City Water, Light & Power
Coal Combustion Residuals Surface Impoundments

Groundwater Monitoring Program

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1. INTRODUCTION

City Water, Light and Power (CWLP) owns and operates two (2) existing coal combustion residual (CCR) surface impoundments and intends to comply with the rules promulgated by the U.S. Environmental Protection Agency (EPA) pertaining to Disposal of CCR from Electric Utilities published in 40 CFR Part 257 on April 17, 2015 in Federal Register, Volume 80, No. 74; and with the Technical Amendments published on July 2, 2015 in Federal Register, Volume 80, No. 127.

The CWLP CCR surface impoundments are located north and east of the former Lakeside Power Generating Station and Dallman Power Generating Station in the Eastern ½ of Section 12, Township 15 North, Range 5 West, in Springfield, Illinois (see Figure 1). These CCR surface impoundments are identified as the Lakeside Ash Pond and the Dallman Ash Pond (see Figure 2).

The former Lakeside Power Generating Station and Dallman Power Generating Station are situated on the northwestern bank of Lake Springfield in Springfield, Illinois. The Lakeside Ash Pond is immediately south of Spaulding Dam at the northern end of Lake Springfield. The Dallman Ash Pond is immediately northwest of the Lakeside Ash Pond.

Placed into service prior to 1958, the Lakeside Ash Pond is primarily a diked embankment. The Lakeside Ash Pond consists of four separate ponds (i.e., three lime softening ponds and a settling pond) totaling approximately 35.0 acres. The Lakeside Ash Pond ceased receiving ash in 2009.

The Dallman Ash Pond was placed into service in approximately 1976 and is also a diked embankment. The Dallman Ash Pond is approximately 34.5 acres. Fly ash and bottom ash are sluiced to the Dallman Ash Pond with raw lake water.

This Groundwater Monitoring Program (GMP) was prepared to meet the groundwater monitoring and corrective action requirements of the Federal CCR Rule Part 257.90-98. The federal rules are specifically addressed in Section 3 and referenced throughout this document.

1.1 REGULATIONS

The two (2) CCR surface impoundments are regulated by Federal CCR Rule 40 CFR Part 257 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (EPA, 2015). As indicated above, the groundwater monitoring and corrective action requirements of the Federal CCR Rule Part 257.90-98 apply to both impoundments.

1.2 SITE DEVELOPMENT

The Lakeside Ash Pond was placed into service prior to 1958 and ceased receiving ash in 2009. The Dallman Ash Pond was placed into service in approximately 1976 and continues to receive ash. The most recent change made to the CCR surface impoundments was a vertical expansion to the Lakeside Ash Pond system in 1988. The vertical expansion consists of berms built on top and inside of the existing embankments in such a way that the toe of the outer slope of the expansion berms matches up with the top of the inner slope of the existing embankments. The vertical expansion berms are approximately ten feet in height.

2. SUBSURFACE CONDITIONS AT THE CCR SURFACE IMPOUNDMENTS

The subsurface conditions of the area in and surrounding the CCR surface impoundments have been characterized through multiple subsurface investigations, including those prior to the impoundment development, along the perimeter of the impoundments and including the hydrogeologic investigation at the permitted Subtitle D CCR landfill located north of the Lakeside Ash Pond and east of the Dallman Ash Pond. These investigations were as follows:

- Professional Service Industries (PSI), June 1989. This investigation consisted of five soil borings within the east section of the south cell (Cell 1).
- Andrews Environmental Engineering, Inc. (AEEI), February 1990. This investigation was performed for Cell 2 and consisted of 13 soil borings. The drilling and testing were completed by PSI.
- Andrews Environmental Engineering, Inc. (AEEI), March 1990. This investigation was performed to install six wells at the Facility. The drilling and testing were completed by PSI.
- Patrick Engineering, Inc. (PEI), July 1992. This investigation was performed to further characterize the hydrogeology of the landfill setting. Approximately 44 soil borings and piezometers were installed by PEI.
- Stabilize, Inc. (SI), December 2008. This investigation installed three new monitoring wells as part of an assessment program for the landfill. The drilling, soil testing, and well construction were performed by Reynolds Well Drilling.
- City Water, Light and Power (CWLP), April 2010. This investigation was performed to install four piezometers on the west side of the CCR surface impoundments along Sugar Creek. The drilling and testing were completed by PSI.
- Stabilize, Inc. (SI), May 2011. This investigation installed four new monitoring wells to further the characterization of the CCR surface impoundments. The drilling, soil testing, and well construction were performed by PSI.
- Andrews Engineering, Inc. (AEI), January 2012. This investigation was performed to replace CCR surface impoundment wells and install an additional background well. The drilling and well installation were completed by TerraDrill.
- Andrews Engineering, Inc. (AEI), July 2017. This project included drilling peripheral to the Dallman Ash Pond.

The summary discussion below of the subsurface conditions is presented in context of the 2015 Federal CCR Rule requirements for groundwater monitoring systems. Emphasis is placed on characterizing the existing wells and hydrogeologic conditions of the uppermost aquifer and underlying confining aquitard. The uppermost aquifer is the required unit for groundwater quality monitoring under the Federal CCR rule.

The occurrence of the deposits discussed below is highly variable due to the meandering nature of Sugar Creek prior to the development of Lake Springfield and Spaulding Dam. The meandering creek has resulted in sequential erosion and deposition (scour and fill) throughout much of the creek drainage system, both laterally and vertically.

2.1 SURFICIAL DEPOSITS

The shallow stratigraphy and lithology at the CCR surface impoundments include approximately 20 to 50 feet of Pleistocene sediments, dependent upon location. In ascending order these materials are identified as basal sand, lower cohesive deposit, shallow sand, upper cohesive deposit and fill material.

The overall tendency is for the finer-grained materials (clays, silty clays and silts) to overlie the coarser-grained materials (sands and gravels). This coarsening downward is present throughout much of the site. At the majority of the borehole locations, the coarser materials rest directly on top of the weathered bedrock surface. It is this coarser material, the basal sand, which is characterized as the uppermost aquifer.

Basal Sand

In most locations, the basal sand is the lower-most surficial deposit. The basal sand is a gray colored, poorly graded, silty to clayey fine sand to well graded sand with minor amounts of fine gravel. This unit was encountered in a medium dense to dense condition. The top elevation of the basal sand varies from 491 to 513 feet mean sea level (MSL) and the thickness ranges from about 0 to 12.3 feet. The unit was not encountered consistently, likely due to excessive erosion of the creek bottom.

The basal sand generally overlies the bedrock surface and underlies the lower cohesive deposit. There are some pockets of very hard, fine grained silty clay to clay overlying bedrock in a few areas. The basal sand is present above these pockets of clayey deposits, thought to be weathered bedrock.

The basal sand generally consists of 0% to 34% gravel, 50% to 91% sand, and 6% to 44% silt/clay; and exhibits a mean field hydraulic conductivity of 1.73×10^{-2} cm/sec. The basal sand was saturated in all locations where it was encountered.

Lower Cohesive Deposit

The lower cohesive deposit consists of brown, gray, and brownish gray silty clays, clayey silts, and clays, having very soft to stiff consistency. The lower cohesive deposit ranges in thickness from 0 to 22 feet with an average thickness of about 15 feet. The deposit was not encountered in isolated areas along the abandoned creek, possibly due to excessive erosion of creek bottom in these areas.

The lower cohesive deposit is generally overlain by the shallow sand and underlain by the basal sand. However, within the abandoned creek area, the lower cohesive deposit was encountered directly below the creek fill. In some areas the basal sand is not present and the lower cohesive deposit directly overlies the bedrock.

The soils in the lower cohesive deposit can be similar in color and texture to the soils in the upper cohesive deposit. The distinction between the two deposits was based on the presence or changes in soil consistency (as measured with a calibrated hand held penetrometer) and a marked difference in moisture content. The lower cohesive deposit is not exposed at the ground surface in the investigated area.

The lower cohesive deposit consists of 0% gravel, 8% to 48% sand, and 52% to 95% silt/clay; and has a relatively low hydraulic conductivity. The vertical hydraulic conductivity ranges from

1.3 x 10^{-8} to 1.8 x 10^{-6} cm/sec (triaxial permeameter). The horizontal hydraulic conductivity ranges from 4.6 x 10^{-5} to 7.6 x 10^{-5} cm/sec (field slug tests).

Shallow Sand

The shallow sand overlies the lower cohesive deposit and underlies the upper cohesive deposit. The unit consists of a brown to gray silty to clayey fine sand. It contains small lenses of silty clay and clayey silt. This unit is not continuous over the entire site. Its thickness ranges from one to three feet over most of the investigated area.

Laboratory tests performed on representative samples collected from the shallow sand unit during this and previous investigations indicate the shallow sand contains 0% gravel, 50% to 52% sand, and 48% to 50% silt/clay. Two landfill piezometers were screened in the shallow sand unit to obtain potentiometric surface information and conduct field hydraulic conductivity tests. The hydraulic conductivity of this unit based on the slug test results ranges from 3.6 x 10^{-3} to 2.9 x 10^{-2} cm/sec.

Upper Cohesive Deposit

The upper cohesive deposit has a relatively low hydraulic conductivity in the vertical direction as determined by laboratory triaxial hydraulic conductivity tests from borings taken from the landfill investigation. The hydraulic conductivity values determined from the laboratory tests ranged from 1.6 x 10^{-5} cm/sec to 5.2 x 10^{-7} cm/sec. However, the upper cohesive deposit is an alluvial deposit and it is expected that the horizontal coefficient of hydraulic conductivity will be greater than the vertical coefficient. Based on test results for the lower cohesive deposit, it is anticipated that the horizontal hydraulic conductivity for the upper cohesive deposit is in the range of 10^{-6} to 10^{-5} cm/sec.

Creek Fill Material

The· borings made along the abandoned creek locations indicate that the creek fill materials consist of variable soils ranging from silty clays to silty sands. Cohesive soils characterized as silty clays to organic silty clay were typically encountered. In some areas, the cohesive fill materials extended down to the top of bedrock. The granular fill materials are typically poorly graded silty to clayey sands and contain organics or wood fragments. In some areas, the granular fill materials also extended down to the top of bedrock.

The cohesive fill material contains 0% gravel, 2% to 48% sand, and 52% to 98% silt/clay. The vertical hydraulic conductivity ranges from 7.6 x 10^{-8} cm/sec to.2.1x10^{-5} cm/sec. The granular fill materials contain 0 to 2% gravel, 55% to 65% sand and 33% to 45% silt/clay. Based on one laboratory hydraulic conductivity test performed on a Shelby tube sample obtained from berm fill, the hydraulic conductivity of the granular fill material is 3.3 x 10^{-8} cm/sec.

The creek fill materials identified during the previous landfill investigations have a significant effect on the site hydrogeologic conditions. In some areas the till materials, consisting of either granular soils or organic silty clays, extend from existing grade to the bedrock surface and locally interconnect all three water bearing units. The upper and lower cohesive deposits are considered to act as aquitards (where present) which restrict vertical flow into the water bearing units. For all practical purposes, the bedrock is considered to be an aquiclude.

Fill materials encountered in the landfill borings range from silty clays and organic silty clays to silty sands and clayey sands. These water level measurements indicate that groundwater

movement within the creek fill materials is complicated because of the highly variable hydraulic characteristics of the fill materials and their random placement. In some areas, there appears to be direct hydraulic communication between fill materials, shallow sand, and basal sand.

Four landfill piezometers are screened into the fill materials. Of these, one piezometer was installed into cohesive fill material and the other piezometers were installed in granular till materials. Hydraulic conductivity of the granular fill materials is based on one field test resulting in a value of 6.1×10^{-2} cm/sec. The hydraulic conductivity of the cohesive fill material ranged from 7.1×10^{-5} cm/sec to 1.1×10^{-4} cm/sec. These values represent the hydraulic conductivity in the horizontal direction.

Laboratory hydraulic conductivity test performed on landfill cohesive fill materials ranged from 2.1×10^{-3} cm/sec to 3.3×10^{-8} cm/sec. The higher hydraulic conductivity values are believed to be typical of soils which contain organic matter (e.g. wood fragments). The hydraulic conductivity values based on laboratory tests are generally considered to be representative of the coefficient of hydraulic conductivity in the vertical direction because of the sample configuration during testing. However, because of the randomness of the fill, it is more likely that the hydraulic conductivity is within the range of 10^{-5} to 10^{-4} cm/sec.

2.2 UPPERMOST BEDROCK

The bedrock at the project site consists of Pennsylvanian shales which are gray in color. The bedrock surface elevation varies from approximately 492 feet MSL near the center of the existing landfill, to approximately 554 feet MSL located on a bedrock outcrop near the landfill area (southeast corner of Cell 1). In general, the bedrock surface slopes from the east and west towards the center of the landfill area.

Rock Quality Designation (RQD) measurements were performed on all core samples taken from the landfill area. RQDs measured from core samples collected during this investigation ranges from 80% to 100%. The RQD values indicate that the bedrock is not highly fractured. Two in situ hydraulic conductivity tests were performed to determine the hydraulic conductivity of the upper portions of the bedrock. Test results indicate hydraulic conductivity values of 1.8×10^{-7} cm/sec and 1.3×10^{-6} cm/sec. This shows that the bedrock encountered at the project site is relatively impermeable. There is good correlation between the lithology of the rocks tested and the hydraulic conductivity values obtained. The upper bedrock beneath the impoundments is expected to exhibit the same characteristics as encountered at the landfill.

2.3 HYDROGEOLOGIC UNITS

The uppermost aquifer and underlying confining unit control groundwater movement and the potential for CCR impacted groundwater migration at the site. A description of the uppermost aquifer and the underlying confining unit follows:

Uppermost Aquifer

The uppermost aquifer is characterized as the basal sand overlying the shale bedrock. In some locations the creek fill materials, ranging from silty clays and organic silty clays to silty sands and clayey sands, were found to be in direct hydraulic communication with the basal sand that directly overlies the bedrock surface. Due to the highly variable hydraulic characteristics and random placement of the creek fill materials, further characterization is difficult.

As indicated above, the hydraulic conductivity of the basal sand ranges from 5.6 x 10^{-4} to 3.6 x 10^{-2} cm/sec. The groundwater in the basal sand appears to be under confined, semi-confined, or unconfined conditions dependent upon location. The upper limit of the uppermost aquifer is dependent upon the seasonally fluctuating groundwater table. The potentiometric surface of the basal sand varies from 565 feet MSL at upgradient locations, south of the Lakeside Ash Pond, to 525 feet MSL at downgradient locations near Sugar Creek, north of the Dallman Ash Pond. As a result, the saturated thickness is variably dependent upon the location and the seasonal variation in the groundwater table.

Lower Confining Unit

The uppermost bedrock at the project site is primarily Pennsylvanian age shale with isolated thin coal layers. The Pennsylvanian shale functions as a lower confining unit due to its low permeability and effective porosity. The lower confining unit represents a natural hydrogeologic barrier (i.e., aquitard) to the vertical movement of groundwater.

In situ hydraulic conductivity test (slug tests) indicate that the hydraulic conductivity for the upper portions of the bedrock range from 1.8 x 10^{-7} to 1.3 x 10^{-6} cm/sec. There appears to be good correlation between the rock lithology and the measured values of hydraulic conductivity. The bedrock over most of the site will act as an aquiclude and prevent the downward movement of groundwater.

2.4 GROUNDWATER MOVEMENT

Groundwater movement is controlled by recharge along topographic highs and discharge along the original stream valley. The pre-surface impoundment flow direction in the uppermost aquifer was dominantly horizontal from the adjacent banks toward the natural convergence along Sugar Creek, which formerly drained the site. This was overall from south to north with local deviations. This dominant flow pattern persists under present day conditions but with localized variation introduced by the hydrologic discontinuity created upon construction of the CCR surface impoundments.

Existing wells at the site, including wells from the Flue Gas Desulfurization Systems (FGDS) Landfill, were used to derive potentiometric surface maps for 2016 and 2017. As shown, overall groundwater movement is from south to north (see Appendix A). The east perimeter of the Lakeside Pond is largely upgradient, and the west side is largely sidegradient where groundwater movement is parallel to the perimeter. Excavated areas within the landfill boundary act as a groundwater sink along the east side of the Dallman Ash Pond. Groundwater generally moves northward from the Dallman Ash Pond but also moves easterly towards the FGDS Landfill and westerly towards Sugar Creek.

3. GROUNDWATER MONITORING AND CORRECTIVE ACTION – 40 CFR §257.90 THROUGH §257.98

The following sections specifically address the sub rules pertaining to Groundwater Monitoring and Corrective Action under sections Applicability (§257.90), Groundwater Monitoring Systems (§257.91), Groundwater Sampling and Analysis Requirements (§257.93), Detection Monitoring Program (§257.94), Assessment Monitoring Program (§257.95), Assessment of Corrective Measures (§257.96), Selection of Remedy (§257.97), and Implementation of the Corrective Action Program (§257.98).

3.1 APPLICABILITY – §257.90

Owners of existing CCR surface impoundments are required to install groundwater monitoring systems, develop a sampling and analysis program to include statistical procedures to be used for evaluating monitoring data, and initiate detection monitoring and evaluation of data for "statistically significant increases (SSI)" over background levels for selected constituents. If detected constituents are measured at a "statistically significant level (SSL)" over the established background level, the facility must conduct assessment monitoring, and if necessary, initiate corrective action responses to control the release.

The facility must make available an annual groundwater monitoring and corrective action report, the first of which is due no later than January 31, 2018. The report must document the status the groundwater monitoring and corrective action program, summarize actions completed, describe problems encountered, and identify activities for the upcoming year. The content of the report is prescribed in §257.90(e). The report must be placed in the facility's operating record and comply with the recordkeeping requirements in §257.105(h), notification requirements in §257.106(h), and internet requirements in §257.107(h).

3.2 GROUNDWATER MONITORING SYSTEM – §257.91

The rule for Groundwater Monitoring Systems (GMS) is a performance standard (§257.91(a)), where the system must consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that: (1) accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit, and (2) accurately represent the quality of groundwater passing the impoundment boundary of the CCR unit to monitor potential contaminant pathways in the uppermost aquifer.

Under §257.91(b-c) the number, spacing, and depths of the groundwater monitoring wells have been determined based upon site-specific technical information to meet the rule's performance standard, including the subsurface conditions observed at the site as summarized in Section 2 of this document. This includes a characterization of the uppermost aquifer.

The monitoring well locations take into consideration the natural (pre-surface impoundment) and current convergence of groundwater flow paths. The wells are located as close as feasible to the downgradient CCR surface impoundments based on topography, surface impoundment construction, and operations. The existing monitor well network (number of wells, locations, and screen interval) was installed pursuant to recommendations of the Illinois EPA Bureau of Water. The network consists of six monitor wells screening the silt, sand, and gravel at the bedrock interface. The direction of groundwater movement, as described above, is to the west-northwest; therefore, the northern and western boundaries of the impoundments will be downgradient, and the southern and eastern boundaries will be upgradient. The monitoring network includes two upgradient wells (wells AP-4 and AP-5) and four downgradient wells (AP-1, AP-2, AP-3, and AW-3). The well locations are depicted in Figure 2 and Figure 3. Table 1 provides a summary of well construction and the approximate screened intervals. Appendix B contains the well completion reports.

Pursuant to §257.91(e), the monitoring wells are constructed in a manner that maintains the integrity of the monitoring well and borehole. All wells were installed pursuant to the Illinois Department of Public Health Water Well Construction Code (77 IAC 920) for monitoring well construction standards. All monitoring well installations were documented in the respective reports. Well construction details are provided in Appendix B. All drilling and groundwater

monitoring well construction was completed under the direct supervision of an Illinois Licensed Professional Geologist.

Background Quality – §257.91(1)

Two (2) groundwater monitoring wells are representative of background (ambient) groundwater quality conditions of the uppermost aquifer. These wells are identified as AP-4 and AP-5. Background concentrations are chemical concentrations or parameter values that represent naturally-occurring groundwater that has not been impacted by the surface impoundment or other facility activities.

Monitoring well AP-4 is located in an upgradient position, southwest of the CCR surface impoundments and along the eastern bank of Sugar Creek, immediately north of Lake Springfield dam. The well screen elevation is approximately 494.9 to 504.9 feet MSL at the surface of the Pennsylvanian shale, screening the basal sand. This well is not upgradient of the subject CCR surface impoundments in a hydrologic sense but it is located on available CWLP property where it provides representative background groundwater quality, as allowed under §257.91(a)(1)ii.

Monitoring well AP-5 is located in an upgradient position, southeast of the CCR surface impoundments and in a topographically slightly higher position. The well screen elevation is approximately 554.44 to 563.78 feet MSL. The screened section of AP-5 is also located at the top of Pennsylvanian shale and screened across the basal sand at this location. This well monitors the upgradient groundwater quality of the uppermost aquifer at this location.

Background concentrations for AP-4 and AP-5 were developed from samples collected for eight consecutive quarters, allowing the statistical method employed to account for seasonal/temporal variability. The chemical constituents include only those parameters Contained in Appendices III and IV of Part 257 (Tables III-2 and III-3, respectively).

The background concentrations are statistically analyzed to establish site-specific upper confidence limits for each chemical or parameter. The statistical methodology utilized for derivation of the background concentrations is provided in Appendix C. The data, calculations and resulting background concentrations are provided in Appendix D.

Results from the background wells (AP-4 and AP-5) will be continually evaluated. If the groundwater quality significantly changes, it will become necessary to revise the background concentrations. In such an event, the statistical method contained in Appendix C will be utilized for such revision. Details for any revision will be placed in the facility record.

Downgradient Quality - §257.91(2)

Four (4) groundwater wells allow monitoring of the downgradient groundwater quality conditions in the uppermost aquifer. These wells are identified as AP-1, AP-2, AP-3 and AW-3. The locations and depths of these wells accurately represent the quality of groundwater passing the impoundment boundaries of the CCR units and reasonably make possible the detection of geochemical changes in the uppermost aquifer. These groundwater monitoring wells are all screened at the top of the weathered bedrock surface. Monitoring wells AP-1, AP-2, AP-3 and AW-3 are located along the toe of the CCR surface impoundments and adjacent to Sugar Creek. Further details are listed below:

Monitoring well AP-1 is screened from approximately 504.63 to 514.01 feet MSL. The screened zone consists of a sand at the surface of the Pennsylvanian shale.

Monitoring well AP-2 is screened from approximately 515.54 to 525.19 feet MSL. The screened zone consists of a clayey sand to sand at the surface of the Pennsylvanian shale.

Monitoring well AP-3 is screened from approximately 514.7 to 524.7 feet MSL. The screened zone consists of a clayey silt at the surface of the Pennsylvanian shale.

Monitoring well AW-3 is screened from approximately 496.32 to 506.32 feet MSL. The screened zone consists of a silt and silty sand at the surface of the Pennsylvanian shale.

3.3 GROUNDWATER SAMPLING AND ANALYSIS REQUIREMENTS – §257.93

The Groundwater Monitoring Program (GMP) includes consistent sampling and analysis procedures to provide accurate representation of groundwater quality (§257.93(a)). The activities include sample collection, preservation and shipment, analytical procedures, chain of custody, and quality assurance and quality control.

Groundwater is sampled for the constituents listed in Appendices III and IV of Part 257 (§257.93(b)). For detection monitoring, these constituents include boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids from Appendix III Part 257 (Table III-2); and for assessment monitoring (if necessary) these constituents include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, and radium 226 & 228 combined from Appendix IV Part 257 (Table III-3). All constituents are analyzed as total recoverable, where samples are not field filtered.

Pursuant to §257.93(c), groundwater levels will be measured in each groundwater monitoring well immediately prior to purging, and each time groundwater is sampled. Other wells may be retained as water level measurement points. Levels will be measured to the nearest 0.01 feet (1/100 hundredth) and used to determine rate and direction of groundwater movement each time groundwater is sampled. In addition, a water table map/potentiometric surface map for the uppermost aquifer will be generated using the measured water levels obtained from each sampling event. The contours on these maps will allow for a quantitative assessment of flow rate and direction. Measurements of well depths will also be obtained during each sampling event to verify that the wells are physically intact and not filling with sediment, except where such measurements are not possible due to the presence of dedicated sampling equipment in the well.

Pursuant to §257.93(d), the background groundwater quality has been established for each of the constituents listed in Appendices III and IV of Part 257 (see Tables III-2 and III-3) by using the upgradient and background wells described under §257.91(a)(1), as applicable for detection (§257.94(a)) or assessment (§257.95(a)) monitoring requirements. The upgradient and background wells include AP-4 and AP-5.

The number of samples collected under detection and assessment monitoring, if necessary (for both downgradient and background wells), will be consistent with the statistical procedures selected under §257.93(f) and the performance standard under §257.93(g). The sampling procedures are consistent with that specified under §257.94(b-d) for detection monitoring and §257.95(b-d) for assessment monitoring, and §257.96(b) for corrective action.

Pursuant to §257.93(f), the selected statistical method to be used during detection monitoring in evaluating groundwater monitoring data for each constituent is the Prediction Interval Procedure under §257.93(f)(3). For this procedure, an interval for each constituent is established from the distribution of the background data and then the level of each constituent in each compliance well (i.e., well/constituent) is compared to the upper prediction limit to assess if a statistically significant increase (SSI) over background has occurred.

The selected method to evaluate concentrations obtained as part of the detection monitoring program is appropriate to determine the occurrence of statistically significant changes in the groundwater quality data and complies with the performance standards under §257.93(g), including:

(1) §257.93(g)(1) addressing the distribution of constituents where normal distributions will use parametric methods and non-normal distributions will use non-parametric methods.

(2) §257.93(g)(4) addressing the effectiveness of this approach by considering the number of samples in the background database, the data distribution, and the range of concentrations values for each constituent of concern.

(3) §257.93(g)(5) establishing the practical quantitation limit as the lowest concentration level that can be reliably achieved during routine laboratory operating conditions.

(4) §257.93(g)(6) allowing for the correction of seasonal and spatial variability as well as temporal correlation in the data.

The methodology to screen background data and establish background constituent levels is provided in Appendix A. This selected statistical approach will be effective in detecting changes in groundwater quality based on the use of interwell prediction limits (EPA, Unified Guidance, 2009). The statistically calculated interwell prediction limits (Appendix D) will be used during detection monitoring to statistically analyze detected inorganic constituents at each monitoring well (i.e., well/constituents) to determine under §257.93(h) whether or not there is a statistically significant increase (SSI) over background values. The SSI determination(s) will be completed within 90 days of completing sampling and analysis, where under §257.93(h)(2)(i), analysis is for total recoverable metals of non-field filtered samples. Volatile organic compounds and synthetic compounds are not applicable to this CCR site. Inorganic well/constituent pairs with confirmed SSI (i.e., interwell prediction limit exceedances) will then be placed into the Assessment Monitoring Program under §257.95.

3.4 DETECTION MONITORING PROGRAM – §257.94

Pursuant to §257.94(a), the Detection Monitoring Program includes, at a minimum, groundwater monitoring for all constituents listed in Appendix III to Part 257, including boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids (TDS). The long-term monitoring frequency for the Appendix III constituents under §257.94(b) will be semiannual during the active life of the CCR unit and the post closure period.

Pursuant to §257.94(b), eight (8) independent samples were collected from each background and downgradient well and analyzed for the constituents listed in Appendix III to Part 257 including boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids (TDS); and for the constituents listed in Appendix IV to Part 257 including antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, and radium 226 & 228 combined. The initial eight (8) independent sampling events were

completed over the second quarter 2015 through first quarter 2017 (§257.94(b)). This schedule allowed the capture of seasonal variability in quality and groundwater flow conditions. Details for derivation of the background concentrations were discussed in Section 3.2 above.

The number of samples collected and analyzed are consistent with the sampling and statistical procedures referenced in §257.93(e) and account for any unique characteristics of the site (§257.94(c)). Sampling for detection monitoring will occur on a semi-annual basis.

Alternative monitoring frequency for repeated sampling and analyses for constituents listed in Appendix III of Part 257 during the active life and the post-closure period based on the availability of groundwater may be implemented pursuant to §257.94(d). However, as stated above, detection monitoring will occur on a semi-annual basis, beginning in October/November 2017 such that the first Groundwater Monitoring and Corrective Action Report can be completed by January 31, 2018.

Pursuant to §257.94(e), if the facility determines pursuant to §257.93(h) that there is a statistically significant increase (SSI) over background levels for one or more of the constituents listed in Appendix III to Part 257 at any monitoring well, within 90 days of this determination the facility will establish an assessment monitoring program meeting the requirements of §257.95 and prepare a notification for the facility's operating record stating that an assessment monitoring program has been established. Such a determination for SSI will occur under the Detection Monitoring Program after completion of the initial 8 independent sampling events and the initial statistical evaluation. As applicable, the facility may also demonstrate that a source other than the CCR unit(s) caused the SSI, or that the SSI was the result of error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The demonstration must be in writing and completed within 90 days of detecting the SSI. If the demonstration is successful, then detection monitoring may continue.

Given the variability of the groundwater chemistry within the facility area, confirmation sampling may be conducted within 90 days of the observation of the SSI. This aids in preventing false positives and prematurely implementing an assessment monitoring program. If resampling occurs due to a SSI, then the SSI will be recorded in the facility record noting that resampling will occur. Within 90 days of the initial observed SSI, the results of the resample event must be placed in the facility record. If the SSI is not confirmed, detection monitoring will continue. If the SSI is confirmed, assessment monitoring pursuant to §257.95 must be initiated.

3.5 ASSESSMENT MONITORING PROGRAM – §257.95

Except as stated above, assessment monitoring is required pursuant to §257.95(a) whenever a SSI has been detected during detection monitoring for one or more of the constituents in Appendix III of Part 257. Under §257.95(b), within 90 days of triggering an assessment monitoring program, and annually thereafter, the facility must sample and analyze the groundwater for all constituents listed in Appendix IV to Part 257 until detection monitoring resumes. An alternative monitoring frequency may be considered if documented under the requirements of §257.95(c).

After obtaining the results from the initial and subsequent sampling events required under §257.95(b), the facility must within 90 days of obtaining the results, and on at least a semiannual basis thereafter, resample all wells that were installed pursuant to §257.91 and conduct analyses for all constituents in Appendix III and for those constituents in Appendix IV to Part 257 that are detected. The results must then be placed in the operating record.

Groundwater Protection Standards (GWPS) will be established for all constituents detected pursuant to §257.95(b or d) and in accordance with the requirements of §257.95(h). These activities and results will be summarized in the annual groundwater monitoring and corrective action report required under §257.90(e).

Pursuant to §257.95(e), if the concentration of all constituents listed in Appendix III and Appendix IV of Part 257 are shown to be at or below background values, using the statistical procedures in §257.93(g), for two consecutive sampling events, the facility may return to the detection monitoring and place notification in the operating record. If the concentrations of any constituent in Appendix III and Appendix IV to Part 257 are above background values, but all concentrations are below the GWPS, assessment monitoring must continue (§257.95(f)).

If one or more constituents in Appendix IV to Part 257 are detected at statistically significant levels (SSL) above the GWPS, the facility must place notification in the operating record and proceed to characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected (§257.95(g)). The characterization must meet the requirements of §257.95(g)(1) and the public notification the requirements of §257.95(g)(2). Under §257.95(g)(3), within 90 days of finding that any of the constituents listed in Appendix IV to Part 257 have been detected at a SSL exceeding the GWPS, the facility must either initiate an assessment of corrective measures under §257.96, or demonstrate an error in any such determination.

A GWPS must be established for each constituent in Appendix IV to Part 257 detected in the groundwater. The GWPS shall be: (1) for constituents for which a maximum contaminant level (MCL) has been established, the MCL for that constituent, or (2) for constituents for which an MCL has not been established, the background concentration for the constituent established from wells in accordance with §257.91, or (3) for constituents for which the background level is higher than the MCL identified under §257.95(h)(1), the background concentration shall be the GWPS.

3.6 ASSESSMENT OF CORRECTIVE MEASURES – §257.96

Within 90 days of determining that any constituent listed in Appendix IV of Part 257 has been detected at a SSL exceeding the GWPS, or immediately upon detection of a release, the facility must initiate an assessment of corrective measures to prevent further releases, to remediate releases, and to restore the affected area to original conditions (§257.96(a)). The assessment must be completed within 90 days unless a time extension of not more than 60 days is needed to complete the assessment, as demonstrated by the facility. The facility will include any such demonstration in the annual groundwater monitoring and corrective action report required under §257.90(e). The CCR unit will continue to monitor groundwater in accordance with the Assessment Monitoring Program during the assessment of corrective measures.

The assessment of corrective measures will evaluate the effectiveness of potential corrective measures in meeting the requirements and objectives of the remedy as described under §257.97, including performance, reliability, ease of implementation, impacts, exposure, time required, permitting, etc. (§257.96(c)).

The completed assessment of corrective measures will be placed in the operating record; discussed at a public meeting at least 30 days prior to the selection of a remedy under §257.97; and recordkeeping, notification, and internet requirements will be met.

3.7 SELECTION OF REMEDY – §257.97

Based on the results of the assessment of corrective measures, a remedy will be selected as soon as feasible that meets the standards listed in §257.97(b), including being protective of human health and environment, attain the GWPS, control the source(s) of release so as to reduce or eliminate, to the extent feasible, further releases on constituents in Appendix IV of Part 257, remove from the environment as much of the contaminated material as feasible, and comply with standards for management of wastes under §257.98(d). In selecting the remedy, the facility will consider the requirements of §257.97(c) and establish a schedule for implementing and completing remedial activities under §257.97(d).

3.8 IMPLEMENTATION OF THE CORRECTIVE ACTION PROGRAM – §257.98

Pursuant to §257.98(a), within 90 days of selecting the remedy, the facility will initiate remedial activities. Based on the schedule provided under §257.97(d) for implementation of remedial activities, the facility must establish and implement a corrective action groundwater monitoring program that meets the requirements of an assessment monitoring program under §257.95, implement the corrective action remedy selected under §257.97, and address any interim measures that might be needed to reduce the contaminants leaching from the CCR unit. If at any time the facility determines that compliance with the requirements of §257.97(b) is not being achieved through the remedy selected, other methods or techniques that could feasibly achieve compliance should be evaluated and implemented (§257.98(b)).

Pursuant to §257.98(c), the remedy will be considered complete when compliance with the GWPS has been achieved at all points within the plume of contamination that lie beyond the groundwater monitoring well system and concentrations of constituents listed in Appendix IV of Part 257 have not exceeded the GWPS for a period of three consecutive years. Table III-7 depicts the methodology for corrective action, where the effectiveness of the remedial actions will be evaluated based on the confidence intervals constructed for applicable well/constituent pairs as compared to a specified clean-up standard which is the GWPS. When the entire interval is determined to be below the standard under §257.98(c) for three consecutive years, that well/constituent pair will be declared to be in compliance, and inorganic well/constituent pairs will be moved back into detection monitoring and appropriate limit-based statistics will resume.

All CCR units that are managed pursuant to a remedy required under §257.97 will be managed in a manner that complies with applicable RCRA requirements (§257.98(d)). Pursuant to §257.98(e), upon completion of the remedy the facility will prepare a notification stating that the remedy has been completed and obtain a certification from a qualified professional engineer.

4. RECORDKEEPING, NOTIFICATION, AND POSTING OF INFORMATION – FEDERAL RULE §257.105 THROUGH §257.107

4.1 RECORDKEEPING REQUIREMENTS – §257.105

CWLP, as owner of an existing CCR unit, will maintain files in its operating record as required under §257.105(h) – groundwater monitoring and corrective action – for a period of no less than five years. This includes:

1. annual groundwater monitoring report,
2. documentation pertaining to monitoring wells,

3. groundwater monitoring certification,
4. selection of statistical method certification,
5. notification within 30 days of establishing an assessment monitoring program,
6. analytical results of Appendices III and IV to Part 257,
7. notification within 30 days of returning to a detection monitoring program,
8. notification within 30 days of detecting of constituents in Appendix IV of Part 257 at statistically significant levels above the groundwater protection standard,
9. notification within 30 days of initiating the assessment of corrective measures,
10. the completed assessment of corrective measures,
11. documentation recording the public meeting for the corrective measures assessment,
12. the semiannual report describing the progress in selecting and designing the remedy and the selection of remedy report, and
13. notification within 30 days of completing the remedy.

4.2 NOTIFICATION REQUIREMENTS – §257.106

Notifications required under §257.106(h) – groundwater monitoring and corrective action – will be sent to the relevant regulatory authority, including for (1) availability of:

1. the annual groundwater report,
2. availability of the groundwater monitoring system certification,
3. selection of a statistical method certification,
4. that an assessment monitoring program has been established,
5. that the CCR unit is returning to a detection monitoring program,
6. that constituent(s) in Appendix IV to Part 257 have been detected at statistically significant levels above the groundwater protection standard and notifications to landowners,
7. that an assessment of corrective measures has been initiated,
8. availability of assessment of corrective measures,
9. the availability of the semiannual report describing the progress in selecting and designing the remedy and the selection of remedy report, and
10. completion of the remedy.

4.3 PUBLICALY ACCESSIBLE INTERNET SITE REQUIREMENTS – §257.107

CWLP will maintain a publicly accessible Internet site (CCR website) containing the information specified in §257.107(h) – groundwater monitoring and corrective action.

http://ehs.cwlp.com/

V. REFERENCES CITED

U.S. Environmental Protection Agency (EPA), March 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. Office of Resource Conservation and Recovery Program Implementation and Information Division, U.S. Environmental Protection Agency, Washington, DC.

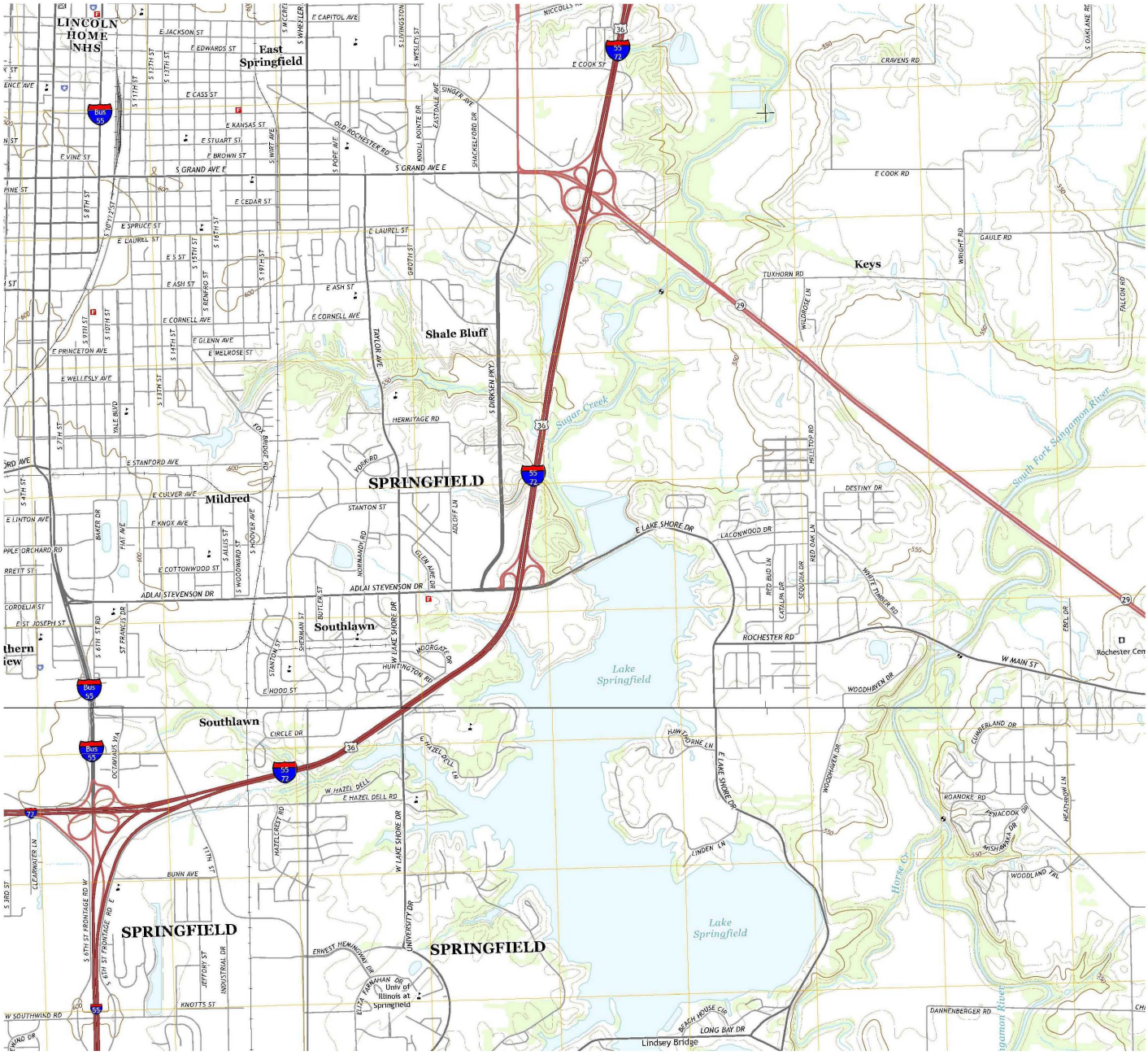
U.S. Environmental Protection Agency (EPA), 2015. Published in Federal Register Volume 80, No. 74 published on April 17, 2015, *Final Rule 40 CFR Part 257 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities*; and *Technical Amendments* (correcting the effective date) published in Federal Register Volume 80, No. 127 on July 2, 2015.

TABLES

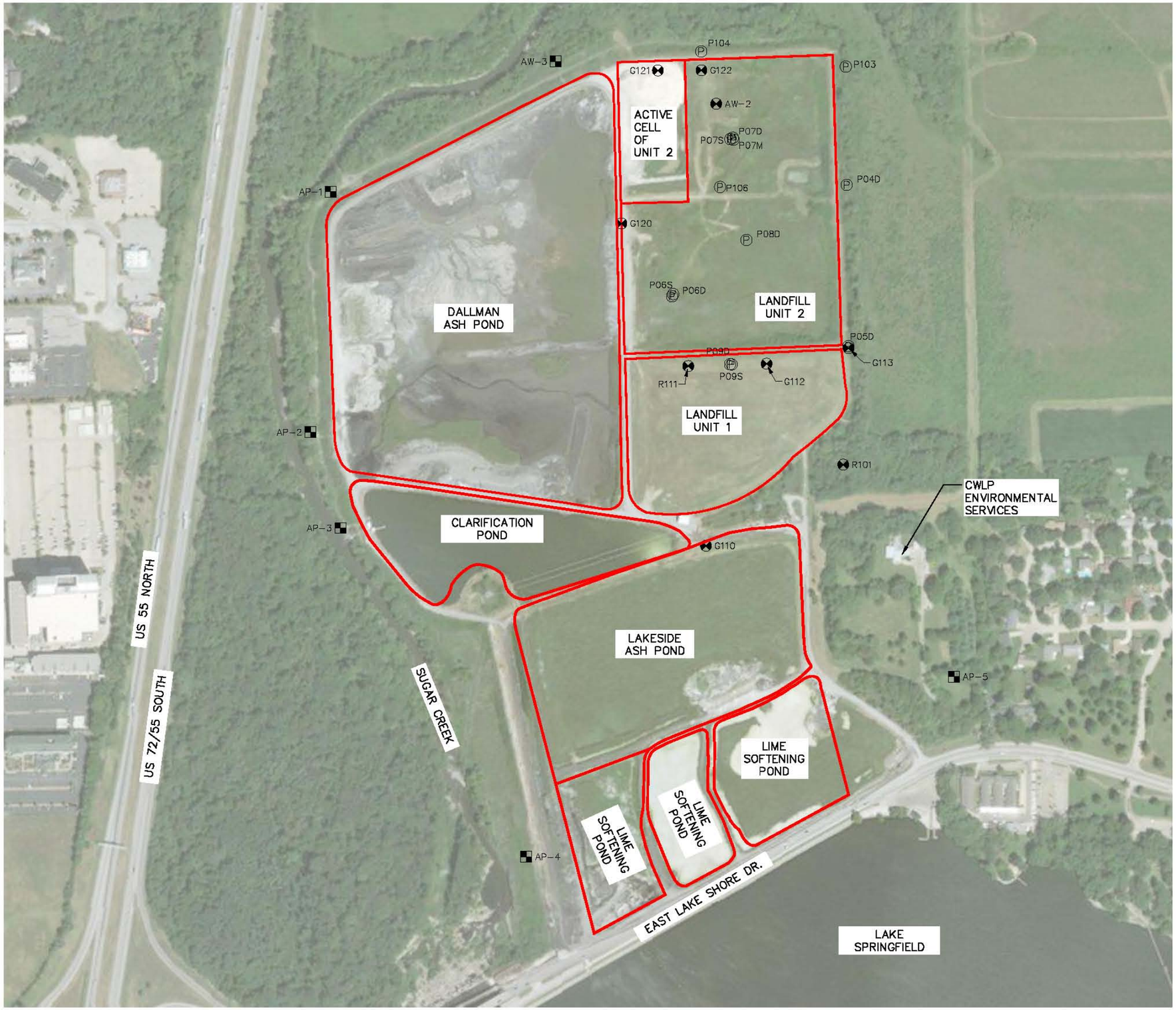
Table 1: Well Construction Summary

Well ID	Monitoring Position	Material Screened	Top of Casing (feet MSL)	Ground Surface (feet MSL)	Top of Screen (feet MSL)	Bottom of Screen (feet MSL)
AP-1	Downgradient	Bedrock/Unconsolidated Interface	535.60	533.10	514.01	504.63
AP-2	Downgradient	Bedrock/Unconsolidated Interface	536.10	533.60	525.19	515.54
AP-3	Downgradient	Bedrock/Unconsolidated Interface	535.40	533.70	524.7	514.7
AP-4	Upgradient	Bedrock/Unconsolidated Interface	559.20	553.90	504.9	494.9
AP-5	Upgradient	Bedrock/Unconsolidated Interface	583.90	581.60	563.78	554.44
AW-3	Downgradient	Bedrock/Unconsolidated Interface	540.33	537.75	506.32	496.32

FIGURES


LINCOLN HOME NHS
East Springfield
Shale Bluff
SPRINGFIELD
Mildred
Southlawn
Keys
Lake Springfield
Sugar Creek
South Fork Sangamon River
Horse Cr
Univ of Illinois at Springfield
Lindsey Bridge
E LAKE SHORE DR
ADLAI STEVENSON DR
ROCHESTER RD
W MAIN ST
E COOK ST
E CAPITOL AVE
E JACKSON ST
E EDWARDS ST
E CASS ST
E KANSAS ST
E STUART ST
E BROWN ST
S GRAND AVE E
E CEDAR ST
E LAUREL ST
E ASH ST
E CORNELL AVE
E GLENN AVE
E MELROSE ST
E WELLESLY AVE
E STANFORD AVE
E CULVER AVE
E KNOX AVE
E COTTONWOOD ST
E HOOD ST
E HAZEL DELL LN
W HAZEL DELL
CRAVENS RD
E COOK RD
TUXHORN RD
GAULE RD
DESTINY DR
LACONWOOD DR
WOODHAVEN DR
CUMBERLAND DR
ROANOKE RD
WOODLAND TRL
DANNENBERGER RD
BEACH HOUSE CIR
LONG BAY DR
LINDEN LN
HAWTHORNE LN
HERMITAGE RD
YORK RD
STANTON ST
CIRCLE DR
BUNN AVE
KNOTTS ST
W SOUTHWIND RD
S 6TH ST FRONTAGE RD W
S 6TH ST FRONTAGE RD E
ERNEST HEMINGWAY DR
UNIVERSITY DR
W LAKE SHORE DR
E LAKE SHORE DR
HAZELCREST RD
OLD ROCHESTER RD
S GRAND AVE E
Bus 55
55
72
36
29
72

ILLINOIS



LEGEND

- ASH IMPOUNDMENT MONITORING WELL LOCATION
- PIEZOMETER LOCATION
- LANDFILL MONITORING WELL LOCATION

N

0 200 400 800

SCALE: IN FEET

NOTE:
BACKGROUND IMAGE DERIVED FROM BING.

NO.	DATE	REVISIONS DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
3300 GINGER CREEK DRIVE
SPRINGFIELD, ILLINOIS 62711-7233
PH (217) 787-2334 FAX (217) 787-9495
PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO
PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

DESIGNED BY: MTH | DRAWN BY: RMC | APPROVED BY: MTH

SITE FACILITIES

PLANS PREPARED FOR
CITY, WATER, LIGHT & POWER
SPRINGFIELD, SANGAMON COUNTY, ILLINOIS

DATE: OCTOBER 2017

PROJECT ID: 170306/0001

SHEET NUMBER:
FIGURE 2

CWLP - 008665

Response to 1st RTP

CWLP ENVIRONMENTAL SERVICES

AP-5

LAKE SPRINGFIELD

EAST LAKE SHORE DR.

LAKESIDE ASH POND

DALLMAN ASH POND

AW-3

AP-1

AP-2

AP-3

AP-4

SUGAR CREEK

LEGEND

ASH IMPOUNDMENT MONITORING WELL LOCATION

N

0 150 300 600

SCALE: IN FEET

NOTE:
BACKGROUND IMAGE DERIVED FROM BING.

REVISIONS			
NO.	DATE	DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
3300 GINGER CREEK DRIVE
SPRINGFIELD, ILLINOIS 62711-7233
PH (217) 787-2334 FAX (217) 787-9495
PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO
PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184001541

DESIGNED BY: MTH | DRAWN BY: RMC | APPROVED BY: MTH

GROUNDWATER MONITORING SYSTEM

PLANS PREPARED FOR
CITY, WATER, LIGHT & POWER
SPRINGFIELD, SANGAMON COUNTY, ILLINOIS

DATE: OCTOBER 2017

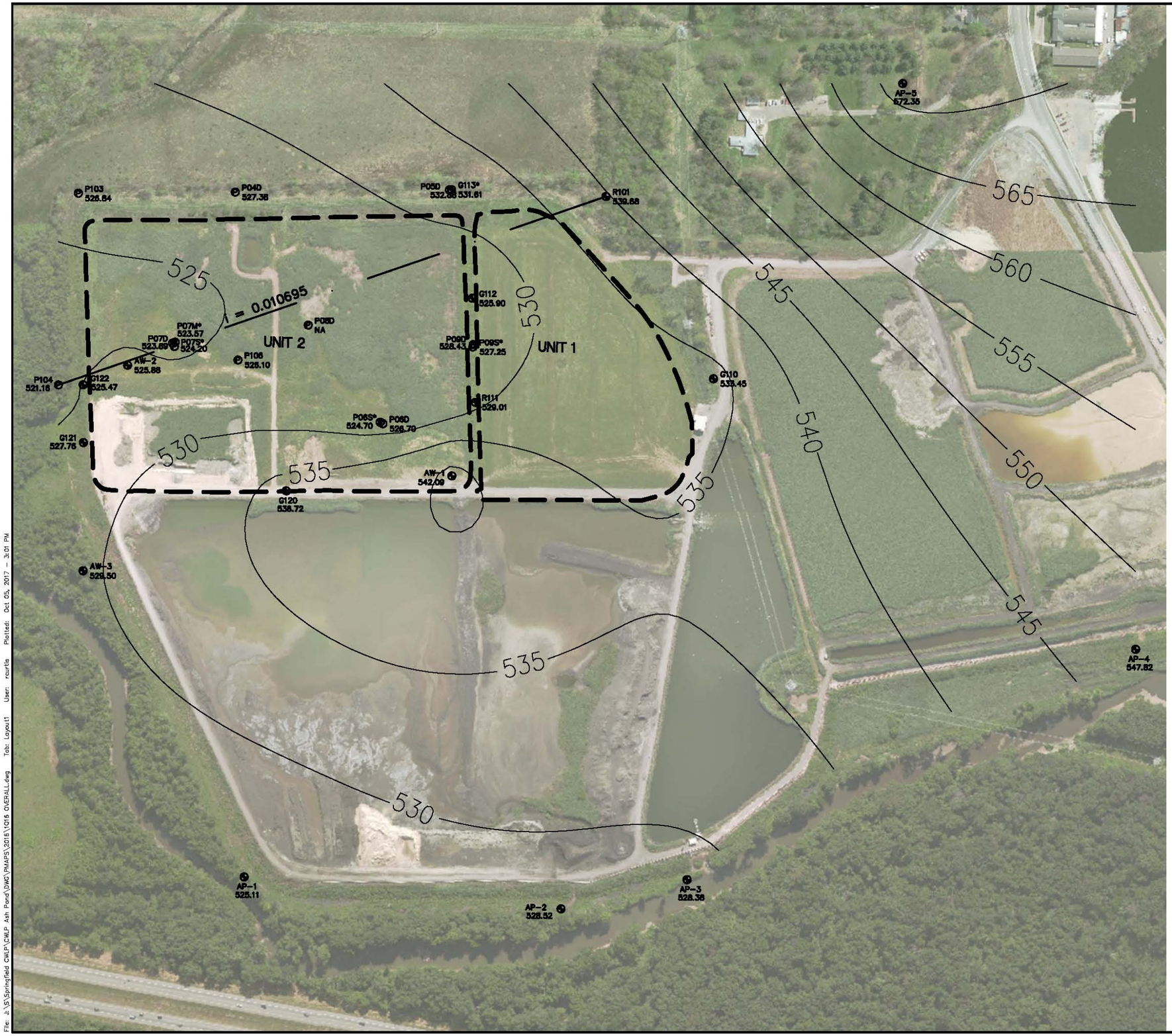
PROJECT ID: 170306/0001

SHEET NUMBER:

FIGURE 3

J:\S\Springfield CWLP\CWLP\dwg\2017\Existing Groundwater Monitoring Network.dwg Tab: FIGURE 3 Last Saved: October 4, 2017, by Ryan Curtis Plotted: Thursday, October 05, 2017 1:09:35 PM

APPENDIX A
POTENTIOMETRIC SURFACE MAPS



LEGEND:

- LANDFILL MONITORING WELL LOCATION
- PIEZOMETER

NOTES:

1. SAMPLING DATE: FEBRUARY 25, 2016.
2. CONTOUR INTERVAL = 5 FEET.
3. i = HYDRAULIC GRADIENT
4. NA = GROUNDWATER ELEVATION NOT AVAILABLE.
5. * IN THE CASE OF NESTED WELLS, THE GROUNDWATER ELEVATIONS FROM DEEPER WELLS (BASAL SAND) WERE USED IN THE COMPILATION OF POTENTIOMETRIC CONTOURS.

N

300 0 300 600

SCALE: IN FEET

ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO

APPROVED BY: CRM | DESIGNED BY: CRM | DRAWN BY: MPN

POTENTIOMETRIC SURFACE MAP
1ST QUARTER 2016

PLANS PREPARED FOR
CITY, WATER, LIGHT, AND POWER
SPRINGFIELD, SANGAMON COUNTY, ILLINOIS

DATE: JUNE 2016

PROJECT ID: 160285/0001

SHEET NUMBER: 1Q16

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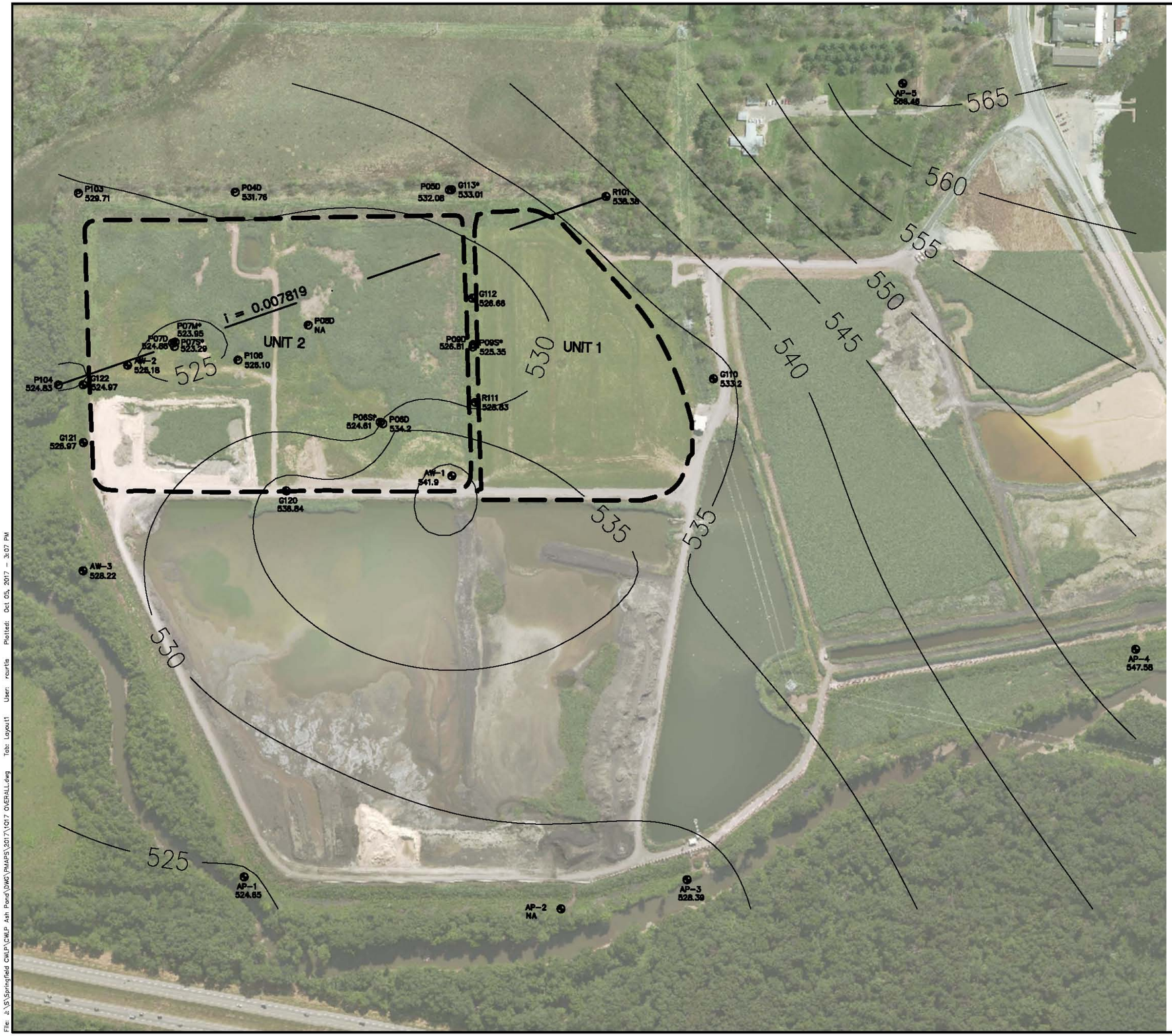

LEGEND:

- LANDFILL MONITORING WELL LOCATION
- PIEZOMETER

NOTES:

1. SAMPLING DATE: FEBRUARY 16, 2017.
2. CONTOUR INTERVAL = 5 FEET.
3. i = HYDRAULIC GRADIENT
4. NA = GROUNDWATER ELEVATION NOT AVAILABLE.
5. * IN THE CASE OF NESTED WELLS, THE GROUNDWATER ELEVATIONS FROM DEEPER WELLS (BASAL SAND) WERE USED IN THE COMPILATION OF POTENTIOMETRIC CONTOURS.

N

300 0 300 600

SCALE: IN FEET

ANDREWS ENGINEERING, INC.
3300 Ginger Creek Drive, Springfield, IL 62711-7233
Tel (217) 787-2334 Fax (217) 787-9495
Pontiac, IL • Naperville, IL • Indianapolis, IN • Warrenton, MO

APPROVED BY: CRM | DESIGNED BY: CRM | DRAWN BY: RMC

POTENTIOMETRIC SURFACE MAP
1ST QUARTER 2017

PLANS PREPARED FOR
CITY, WATER, LIGHT, AND POWER
SPRINGFIELD, SANGAMON COUNTY, ILLINOIS

DATE: OCOTBER 2017

PROJECT ID: 160285/0001

SHEET NUMBER: 1Q17

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APPENDIX B
WELL CONSTRUCTION DETAILS

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Sangamon Well #: AP-1R

Site Name: City Water, Light, & Power Borehole #: AP-1R

Coordinates: X 831.70 Y 5132.40 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed by: _____ IL Registration #: _____

Drilling Contractor: Terra Drill, Inc. Consulting Firm: Andrews Engineering, Inc.

Driller: J. Brown Geologist: M. Hewitt

Drilling Method: 4¼" HSA w/ 5' Continuous Barrel Logged by: M. Hewitt

Drilling Fluids (type): _____ Report Form Completed by: J. Rhoades

Date Well Started: 1/30/2012 Date Well Finished: 1/30/2012 Date Form Completed: 2/27/2012

ANNULAR SPACE DETAILS

Type of surface seal: Concrete

Type of annular sealant: Bentonite Grout

Installation method: Tremie

Setting time: 2 Hours

Type of bentonite seal – Bentonite Chips (circle one)

Installation method: Free drop

Setting time: 2 Hours

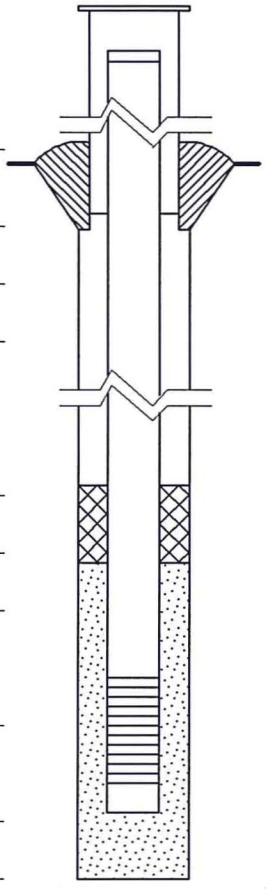
Type of sand pack: Unimin Sand

Grain size: 10/20 (sieve size)

Installation method: Free drop

Type of backfill material: _____ (if applicable)

Installation method: _____



ELEVATION (MSL)®	DEPTH (BGS)♦ (0.01 ft)	
535.60	-2.50	Top of Protective Casing
535.60	-2.50	Top of Riser Pipe
533.10	.00	Ground Surface
530.10	3.00	Top of Annular Sealant
n/a	n/a	Static Water Level Measured on (after completion)
517.00	16.10	Top of Seal
513.51	19.59	Top of Sandpack
514.01	19.09	Top of Screen
504.63	28.47	Bottom of Screen
504.10	29.00	Bottom of Well
500.60	32.50	Bottom of Borehole

® Referenced to a National Geodetic Vertical Datum
♦ positive (+) values below GS, negitive (-) values above GS

CASING MEASUREMENTS

Diameter of Borehole (in)	8.0
ID of Riser Pipe (in)	2.0
Protective Casing Length (ft)	5.0
Riser Pipe Length (ft)	21.59
Bottom of Screen to End Cap (ft)	.53
Screen Length [1st slot to last slot] (ft)	9.38
Total Length of Casing (ft)	31.50
Screen Slot Size*	0.01"

*Hand-slotted well screens are unacceptable.

WELL CONSTRUCTION MATERIALS (circle one)

Protective Casing	SS304, SS316, PTFE, PVC or *Other:Steel*
Riser Pipe Above W.T.	SS304, SS316, PTFE, *PVC*, or Other:
Riser Pipe Below W.T.	SS304, SS316, PTFE, *PVC*, or Other:
Screen	SS304, SS316, PTFE, *PVC*, or Other:

(AE950315)

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Sangamon Well #: AP-2A

Site Name: Springfield City Water, Light, and Power Borehole #: _____

Coordinates: X 735.9 Y 4185.2 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed by: Springfield City Water, Light, and Power IL Registration #: _____

Drilling Contractor: Bulldog Drilling, Inc. Consulting Firm: Andrews Engineering, Inc.

Driller: J. Edwards Geologist: C. Myrvold

Drilling Method: AMS Powerprobe w/ 4.25" HSA and 5' MC Logged by: C. Myrvold

Drilling Fluids (type): na Report Form Completed by: C. Myrvold

Date Well Started: 2/16/2016 Date Well Finished: 2/16/2016 Date Form Completed: 3/06/2016

ANNULAR SPACE DETAILS

Type of surface seal: Concrete

Type of annular sealant: N/A

Installation method: _____

Setting time: _____

Type of bentonite seal: Bentonite chips

Installation method: Free drop

Setting time: 24+ hours

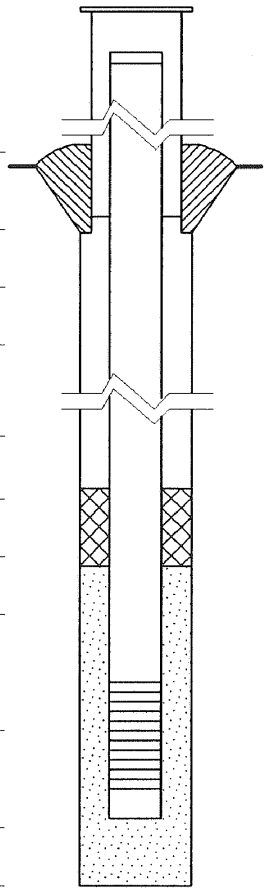
Type of sand pack: Silica sand

Grain size: 20/40 (sieve size)

Installation method: Free drop

Type of backfill material: N/A (if applicable)

Installation method: _____



ELEVATION (MSL)®	DEPTH (BGS)*	(0.01 ft)
536.50	-2.90	Top of Protective Casing
536.10	-2.50	Top of Riser Pipe
533.60	0.00	Ground Surface
	N/A	Top of Annular Sealant
		Static Water Level Measured on (after completion)
530.60	3.00	Top of Seal
527.19	6.41	Top of Sandpack
525.19	8.41	Top of Screen
515.54	18.06	Bottom of Screen
515.10	18.50	Bottom of Well
514.60	19.00	Bottom of Borehole

® Referenced to a National Geodetic Vertical Datum
* positive (+) values below GS, negitive (–) values above GS

Notes:

WELL CONSTRUCTION MATERIALS

Protective Casing	Anodized Aluminum
Riser Pipe Above W.T.	PVC
Riser Pipe Below W.T.	PVC
Screen	PVC

CASING MEASUREMENTS

Diameter of Borehole (in)	8.25
ID of Riser Pipe (in)	2
Protective Casing Length (ft)	5.0
Riser Pipe Length (ft)	10.91
Bottom of Screen to End Cap (ft)	0.44
Screen Length [1st slot to last slot] (ft)	9.65
Total Length of Casing (ft)	21.00
Screen Slot Size*	#10 (0.01)

*Hand-slotted well screens are unacceptable.

Response to 1st RTP

CWLP - 008671

Professional Service Industries, Inc.
480 North Street
Springfield, Illinois 62704
Telephone: 217/544-6663
Fax: 217/544-6143

LOG OF BORING AP-3

Sheet 1 of 1

PSI Job No.: 0020522
Project: Piezometer Installation
Location: CWLP Ash Pond
East Lake Shore Drive
Springfield, Illinois

Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon
Hammer Type: CME Automatic; ETR = 86%
Boring Location: See attached boring location plan.

WATER LEVELS
While Drilling: None feet
Upon Completion: N/A
Delay: N/A

Station: N/A
Offset: N/A

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			1	18	Dark brown silty CLAY, very stiff, slightly moist	CL	6-7-8 N_{60}=21		
	5			2	18	Gray/brown clayey SILT, soft to stiff, moist to saturated	ML	3-3-4 N_{60}=10		
				3	18			1-1-1 N_{60}=3		
	10			4	18	Gray clayey SILT, soft to very stiff, saturated		2-1-2 N_{60}=4		
				5	18			2-2-4 N_{60}=9		
	15			6	16		ML	2-2-4 N_{60}=9		
				7	18			4-4-6 N_{60}=14		
	20			8	10	Gray SHALE, hard, slightly moist Boring terminated at -19.5	CL	32-50/3"		

STANDARD PENETRATION TEST DATA
N in blows/ft
Moisture, PL, LL
0 25 50
STRENGTH, tsf
Qu, Qp
0 2.0 4.0

Well Diagram: J-Plug; Concrete Cap; 2" PVC Solid Riser; Bentonite Seal; Sand Filter Pack; 0.01" PVC Slotted Well Screen

Completion Depth: 20.0 ft
Date Boring Started: 4/21/10
Date Boring Completed: 4/21/10
Logged By: Rob Preuss
Drilling Contractor: PSI, Inc.

Sample Types:
Auger Cutting
Split-Spoon
Rock Core
Shelby Tube
Hand Auger
Texas Cone

Latitude:
Longitude:
Drill Rig: ATV D50
Remarks: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633. Moistures determined by visual methods

The stratification lines represent approximate boundaries. The transition may be gradual.

Professional Service Industries, Inc.
480 North Street
Springfield, Illinois 62704
Telephone: 217/544-6663
Fax: 217/544-6143

LOG OF BORING AP-4

Sheet 1 of 1

PSI Job No.: 0020522
Project: Piezometer Installation
Location: CWLP Ash Pond
East Lake Shore Drive
Springfield, Illinois

Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon
Hammer Type: CME Automatic; ETR = 86%
Boring Location: See attached boring location plan.

WATER LEVELS

While Drilling	11 feet
Upon Completion	N/A
Delay	N/A

Station: N/A
Offset: N/A

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ● × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks	Well Diagram
	0			1	17	Brown silty CLAY, some brown sand, firm to stiff, slightly moist (FILL)	CL	4-4-3 N_{60}=10				J-Plug
				2	18	Brown silty CLAY, trace roots, firm to stiff, moist (FILL)	CL	4-3-2 N_{60}=7				
	5			3	10	Brown SILT, trace gray, firm to stiff, moist (FILL)	ML	6-3-2 N_{60}=7				
				4	12	5" Brown SAND transitioning to Black FLY ASH at 9.4', stiff to very stiff, slightly moist (FILL)		2-2-4 N_{60}=9				
	10			5	18		SAND/FLY ASH	2-2-2 N_{60}=6				
				6	16			2-1-1 N_{60}=3				
	15			7	16			6-6-5 N_{60}=16				
				8	18	Black FLY ASH, some fine sub-round gravel, stiff to very stiff, moist to saturated (FILL)	FLY ASH	3-3-3 N_{60}=9				Concrete Cap
	20					Gray/green (organic?) CLAY, stiff, trace fine sand, moist to saturated						
				9	1		CL	3-3-4 N_{60}=10				2" PVC Solid Riser
	25											
				10	18	Brown/gray silty CLAY, fiorm to stiff, saturated	CL	2-2-3 N_{60}=7				Bentonite Seal
	30											
				11	18	Gray SILT, stiff to very stiff, saturated		3-3-4 N_{60}=10				
	35											
				12	18		ML	4-4-4 N_{60}=11				
	40											
				13	18			4-4-6 N_{60}=14				
	45											
				14	18	Gray fine to coarse SAND, medium dense, saturated		4-5-7 N_{60}=17				
	50											
				15	18		SW	5-5-7 N_{60}=17				Sand Filter Pack
	55											
				16	1	Gray SHALE, hard, moist	CL	50/1"		>>●		0.01" PVC Slotted Screen
	60					Boring terminated at -60'						

Completion Depth: 60.0 ft
Date Boring Started: 4/20/10
Date Boring Completed: 4/20/10
Logged By: Rob Preuss
Drilling Contractor: PSI, Inc.

Sample Types:
Auger Cutting
Split-Spoon
Rock Core
Shelby Tube
Hand Auger
Texas Cone

Latitude:
Longitude:
Drill Rig: ATV D50
Remarks: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633. Moistures determined by visual methods.

The stratification lines represent approximate boundaries. The transition may be gradual.

Illinois Environmental Protection Agency — Well Completion Report

Site #: _____ County: Sangamon Well #: AP-5

Site Name: City Water, Light, & Power Borehole #: AP-5

Coordinates: X 3203.10 Y 3164.10 (or) Latitude: ___° ___' ___" Longitude: ___° ___' ___"

Surveyed by: _____ IL Registration #: _____

Drilling Contractor: Terra Drill, Inc. Consulting Firm: Andrews Engineering, Inc.

Driller: J. Brown Geologist: M. Hewitt

Drilling Method: 4¼" HSA w/ 5' CB & 2' SS Logged by: M. Hewitt

Drilling Fluids (type): _____ Report Form Completed by: J. Rhoades

Date Well Started: 2/1/2012 Date Well Finished: 2/1/2012 Date Form Completed: 2/27/2012

ANNULAR SPACE DETAILS

Type of surface seal: Concrete

Type of annular sealant: Bentonite Grout

Installation method: Tremie

Setting time: 2 Hours

Type of bentonite seal – Bentonite Chips (circle one)

Installation method: Free drop

Setting time: 2 Hours

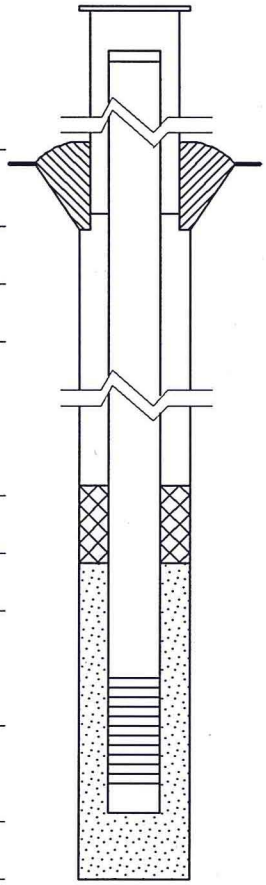
Type of sand pack: Unimin Sand

Grain size: 10/20 (sieve size)

Installation method: Free drop

Type of backfill material: Bentonite Chips (if applicable)

Installation method: Free drop



ELEVATION (MSL)®	DEPTH (BGS)◆ (0.01 ft)	
584.30	-2.70	Top of Protective Casing
583.90	-2.30	Top of Riser Pipe
581.60	.00	Ground Surface
578.60	3.00	Top of Annular Sealant
n/a	n/a	Static Water Level Measured on (after completion)
565.48	16.12	Top of Seal
563.48	18.12	Top of Sandpack
563.78	17.82	Top of Screen
554.44	27.16	Bottom of Screen
553.90	27.70	Bottom of Well
551.10	30.50	Bottom of Borehole

® Referenced to a National Geodetic Vertical Datum
◆ positive (+) values below GS, negitive (-) values above GS

NOTES:

•Borehole AP-5 sampled to 49.0 feet below ground surface (BGS) and backfilled with bentonite chips to 30.5 feet BGS

WELL CONSTRUCTION MATERIALS (circle one)

Protective Casing	SS304, SS316, PTFE, PVC or *Other:Steel*
Riser Pipe Above W.T.	SS304, SS316, PTFE, *PVC*, or Other:
Riser Pipe Below W.T.	SS304, SS316, PTFE, *PVC*, or Other:
Screen	SS304, SS316, PTFE, *PVC*, or Other:

CASING MEASUREMENTS

Diameter of Borehole (in)	8.0
ID of Riser Pipe (in)	2.0
Protective Casing Length (ft)	5.0
Riser Pipe Length (ft)	20.12
Bottom of Screen to End Cap (ft)	.54
Screen Length [1st slot to last slot] (ft)	9.34
Total Length of Casing (ft)	30.00
Screen Slot Size*	0.01"

*Hand-slotted well screens are unacceptable.

(AE950315)

Response to 1st RTP
CWLP - 008674

Illinois Environmental Protection Agency — **Well Completion Report**

Site Number: 1678250020 County: Sangamon

Site Name: FGDS Development Landfill Well #: AW-3

State Plane Coordinate: X ____ Y ____ (or) Latitude: ____ ____ ____ Longitude: ____ ____ ____ Borehole #: AW-3

Surveyed by: David Mihelsic IL Registration #: 3762

Drilling Contractor: Reynolds Drilling Corp. Driller: Andrew Rachford

Consulting Firm: Rapps Engineering & Applied Science Geologist: Ken Miller

Drilling Method: HSA Drilling Fluid (Type): NA

Logged By: Ken Miller Date Started: 12/30/08 Date Finished: 12/31/08

Report Form Completed By: Ken Miller Date: 5/18/09

ANNULAR SPACE DETAILS

Type of Surface Seal: Cement

Type of Annular Sealant: Bentonite Chips

Installation Method: Poured

Setting Time: >24 hrs

Type of Bentonite Seal - - Granular, Pellet, Slurry (Choose One)

Installation Method: Poured

Setting Time: 16 hrs

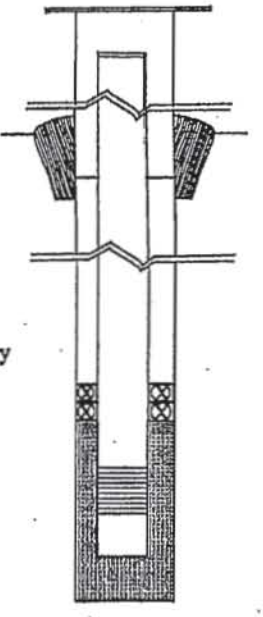
Type of Sand Pack: Quartz Sand

Grain Size: 50 (Sieve Size)

Installation Method: Poured

Type of Backfill Material: (If applicable)

Installation Method:



	Elevations (MSL)*	Depths (BGS)	(.01ft.)
	____	____	Top of Protective Casing
	540.33	-2.58	Top of Riser Pipe
	537.75	0	Ground Surface
	534.75	3.00	Top of Annular Sealant
	____	____	Static Water Level (After Completion)
	511.32	26.43	Top of Seal
	508.32	29.43	Top of Sand Pack
	506.32	31.43	Top of Screen
	496.32	41.43	Bottom of Screen
	495.92	41.83	Bottom of Well
	495.92	41.83	Bottom of Borehole

* Referenced to a National Geodetic Datum

WELL CONSTRUCTION MATERIAL

(Choose one type of material for each area)

Protective Casing	SS304, SS316, PTFE, PVC, or Other
Riser Pipe Above W.T.	SS304, SS316, PTFE, PVC, or Other
Riser Pipe Below W.T.	SS304, SS316, PTFE, PVC, or Other
Screen	SS304, SS316, PTFE, PVC, or Other

CASING MEASURMENTS

Diameter of Borehole (inches)	8.25
ID of Riser Pipe (inches)	2
Protective Casing Length (feet)	5
Riser Pipe Length (feet)	34.01
Bottom of Screen to End Cap (feet)	0.4
Screen Length (1" slot to last slot) (feet)	10
Total Length of Casing (feet)	44.41
Screen Slot Size **	0.010

**Hand-Slotted Well Screens are Unacceptable

Well Completion Form (revised 02/06/02)

APPENDIX C

STATISTICAL METHOD FOR DETERMINATION OF BACKGROUNDS

Statistical Analyses Method

1.0 References

1. "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Unified Final Guidance." USEPA, March 2009.

2.0 Statistical Method

The statistical method includes the calculation of the 95% Upper Prediction Limit (upper and lower for pH) for each parameter utilizing the background data set. Prior to the calculation of the Prediction Limit, the data set is evaluated for normality, outliers and the percentage of non-detect values. Each of the steps for determining the Prediction Limit is outlined below in Sections 2.1 through 2.4.

2.1 Normality Testing

The distribution of the data is tested for normality using the Shapiro-Wilk normality test. If the data is not found to follow a normal distribution, a nonparametric statistical method shall be utilized. Generally, the highest detected concentration is utilized as the Upper Prediction Limit if the data set is found to be nonparametric. If the data is found to follow a normal distribution, the procedures outlined below are used to determine the Prediction Limit.

2.2 Handling of Outliers

Prior to statistical analyses, the data set is evaluated for outliers. Outliers are defined as data points that vary significantly from the mean value of the data set. Outliers may represent sampling error, contamination from surface run-off, analytical laboratory error, or anomalous site conditions. Outliers, if not removed from the data set, can erroneously increase the prediction limit which makes the prediction limit less likely to detect a statistically significant increase related to a release from a waste unit. Once a statistical outlier has been identified, the concentrations shall be evaluated to determine the cause. If the outlier is determined to be a result of sampling, laboratory or some other error, the outlier will be removed from the data set. If no specific reason can be documented the point will be considered representative of site conditions and will be included in the statistical analysis. Statistical analysis will then be conducted as described below. Evaluation for outliers will be completed utilizing Grubb's Test as well as Dixon's Test (both at 1% significance).

2.3 Handling of Non-Detects (NDs)

Non-detect values (NDs) are handled according to the percentage of Non-Detects (%ND) present in the data set. The data treatment is completed according to the following criteria:

a) For under 0% NDs, no adjustment is made to the values in the data set.
b) For under 15% NDs, the value of one-half (½) the reported Detection Limit (DL) is substituted for the ND value, and the mean and standard deviation are calculated using detected values with the substituted ND values.
c) For 15-50% NDs with a single censoring point, Cohen's Adjustment is used to adjust the mean and standard deviation. The adjusted mean and standard deviation are then used to calculate the Prediction Limit.
d) For 15-50% NDs with multiple censoring points:
    - For small data sets (<5): ½ the PQL can be substituted for ND values. The Prediction Limit is then calculated with the dataset containing the substituted values.
    - For larger data sets: Kaplan-Meier is used to adjust the mean and standard deviation. The adjusted mean and standard deviation are then used to calculate the Prediction Limit.
e) For over 50% but not 100% NDs, the highest recorded concentration is substituted for the prediction limit.
f) For 100% NDs, the Practical Quantitation Limit (PQL) will be utilized as the upper confidence limit.

2.4 Calculation of the Prediction Limit

After any outliers are removed and the data has been treated for non-detect values, the statistical procedure for calculation of the Prediction Limit will be conducted according to the following steps:

a) <u>Calculate arithmetic mean</u>

The arithmetic mean is calculated using the pooled data for each parameter. The arithmetic mean (X_b) is calculated using the following equation:

$$X_b = \frac{X_1 + X_2 + \ldots + X_n}{n}$$

where: X_b = Average background value
X_n = Individual background value for *n* sample
n = Number of background values

b) Calculate standard deviation

The standard deviation is calculated using the pooled data for each parameter.

The standard deviation is calculated using the following equation:

$$S_b = \sqrt{\frac{(X_1 - X_b) + (X_2 - X_b) + \ldots + (X_n - X_b)}{n - 1}}$$

where: S_b = Population standard deviation
X_n = Individual background value for *n* sample
X_b = Mean (1)
n = Number of background samples

c) Calculate the 95% Prediction Limit

The 95% Prediction Limit is calculated for each parameter using the mean (1), the standard deviation (2), the number of background samples, and the Student's t value given for α = 0.05 (95% Confidence). The Prediction Limit for pH is calculated as and upper and lower limit. All other Prediction Limits are calculated as an upper limit. The Student's t value varies upon the number of background samples. The 95% Prediction Limit is calculated using the following equation:

$$PL = X_b \pm S_b \bullet t \bullet \sqrt{1 + \frac{1}{n}}$$

where: PL = Upper Prediction Limit (Upper and Lower for pH)
X_b = Mean (1)
S_b = Standard Deviation (2)
t = Student's t value at 0.05 significance
n = Number of background samples

APPENDIX D
BACKGROUND CONCENTRATIONS AND CALCULATIONS

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix III Parameters

Raw Data Summary

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	Distribution[1]	Proposed Background Value
AP-4	Boron, total	mg/l	0.119	0.123	0.787	< 2	< 0.687	0.75	0.665	< 2	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.787
AP-5	Boron, total	mg/l	< 1	< 0.625	0.782	< 3.2	< 0.687	0.22	0.0954	< 2		
AP-4	Chloride, total	mg/l	10.1	9.85	11	10.5	10.8	11	10.7	10.9	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	24.2
AP-5	Chloride, total	mg/l	24.2	7.23	3.32	3.76	3.71	2.61	1.95	2.07		
AP-4	Fluoride, total	mg/l	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.2	< 0.5	< 0.5	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.62
AP-5	Fluoride, total	mg/l	0.62	< 0.5	< 0.5	< 0.5	< 0.5	0.43	< 0.5	< 0.5		
AP-4	pH (field)	units	6.81	7.07	7.63	7.09	7.04	7.23	7.04	7.1	Normal - Calculate Interwell Prediction Limit	6.76-7.63
AP-5	pH (field)	units	7.33	7.19		7.29	7.23	7.46	7.15	7.32		
AP-4	Sulfate, total	mg/l	< 5	< 5	< 5	< 5	< 5	0.3	< 5	< 5	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	84.5
AP-5	Sulfate, total	mg/l	82.3	43.5	76.8	84.5	83.4	55.3	66.8	59.5		
AP-4	Total Dissolved Solids	mg/l	490	560	448	574	460	578	548	316	Normal - Calculate Interwell Prediction Limit	597.94
AP-5	Total Dissolved Solids	mg/l	414	404	316	404	370	410	428	384		
Well	**Parameter**	**Units**	**5/28/15**	**8/20/15**	**11/13/15**	**2/26/16**	**5/13/16**	**8/4/16**	**11/18/16**	**2/16/17**	**Distribution***	**Proposed Background Value**
AP-4	Calcium, total	mg/l	121	117	125	125	118	118	117	136	Normal - Calculate Interwell Prediction Limit	176.63
AP-5	Calcium, total	mg/l	103	92.2	124	98.1	77.3	158	201	155		

Notes:

1. Shapiro-Wilk method utilized to determine if the data set follows a normal distribution. ProUCL 5.1 was used for the calculations. ProUCL 5.1 outputs are provided.
2. In accordance with Chapter 18.3 of the March 2009 Unified Guidance (Statistical Analysis of Groundwater at RCRA Facilities), the maximum detected concentration is utilized as the interwell prediction limit and proposed background when the dataset does not follow a normal distribution.

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix III Parameters

Outlier Analysis

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	Number of Samples	Mean	Standard Deviation	Critical Values
AP-4	pH (field)	units	6.81	7.07	7.63	7.09	7.04	7.23	7.04	7.1	15	7.198666667	0.196136	2.705
AP-5	pH (field)	units	7.33	7.19		7.29	7.23	7.46	7.15	7.32				
AP-4	Total Dissolved Solids	mg/l	490	560	448	574	460	578	548	316	16	444	85.19468	2.747
AP-5	Total Dissolved Solids	mg/l	414	404	316	404	370	410	428	384				
Well	**Parameter**	**Units**	**5/28/15**	**8/20/15**	**11/13/15**	**2/26/16**	**5/13/16**	**8/4/16**	**11/18/16**	**2/16/17**	**Number of Samples**	**Mean**	**Standard Deviation**	**Critical Values**
AP-4	Calcium, total	mg/l	121	117	125	125	118	118	117	136	16	124.1	29.06863	2.747
AP-5	Calcium, total	mg/l	103	92.2	124	98.1	77.3	158	201	155				

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13
AP-4	pH (field)	units	-1.981613	-0.656006	2.1991488	-0.554036	-0.80896	0.1597527	-0.80896	-0.503051
AP-5	pH (field)	units	0.6696017	-0.044187		0.4656621	0.1597527	1.3324055	-0.248127	0.6186168
AP-4	Total Dissolved Solids	mg/l	0.5399398	1.3615874	0.0469513	1.5259169	0.1878052	1.5728682	1.2207335	-1.502441
AP-5	Total Dissolved Solids	mg/l	-0.352135	-0.469513	-1.502441	-0.469513	-0.868599	-0.399086	-0.187805	-0.704269
Well	**Parameter**	**Units**	**5/28/15**	**8/20/15**	**11/13/15**	**2/26/16**	**5/13/16**	**8/4/16**	**11/18/16**	**2/16/17**
AP-4	Calcium, total	mg/l	-0.106644	-0.24425	0.0309612	0.0309612	-0.209848	-0.209848	-0.24425	0.409376
AP-5	Calcium, total	mg/l	-0.725868	-1.097403	-0.00344	-0.894435	-1.609983	1.1662056	2.6454634	1.0630015

Notes:

1. Outlier method presented above outlined is in ASTM paper E178-75 (Grubb's Test).
2. Outliers were also evaluated utilizing Dixon's Test in ProUCL 5.1 at 1% Significance. ProUCL 5.1 output are provided.
3. Outliers that were identified by both methods are noted with a shaded value.

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix III Parameters

Non-Detect Percentage Analysis

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	Number of Samples	Number of ND's	% ND	ND Treatment
AP-4	pH (field)	units	6.81	7.07	7.63	7.09	7.04	7.23	7.04	7.1	15	0	0%	No Adjustment
AP-5	pH (field)	units	7.33	7.19		7.29	7.23	7.46	7.15	7.32				
AP-4	Total Dissolved Solids	mg/l	490	560	448	574	460	578	548	316	16	0	0%	No Adjustment
AP-5	Total Dissolved Solids	mg/l	414	404	316	404	370	410	428	384				
Well	**Parameter**	**Units**	**5/28/15**	**8/20/15**	**11/13/15**	**2/26/16**	**5/13/16**	**8/4/16**	**11/18/16**	**2/16/17**	**Number of Samples**	**Number of ND's**	**% ND**	**ND Treatment**
AP-4	Calcium, total	mg/l	121	117	125	125	118	118	117	136	16	0	0%	No Adjustment
AP-5	Calcium, total	mg/l	103	92.2	124	98.1	77.3	158	201	155				

Notes:

1. For datasets with a fraction of non-detect values from 25% to 50%, adjustments to the mean and standard deviation (SD) are required.
2. For datasets with a single censoring point (RL), Cohen's Ajustment may be used to adjust the mean and SD or a substitution of 1/2 the RL may be used for small datasets (<5) in accordance with Section 15.2 of the March 2009 Unified Guidance (Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities).
3. Kaplan-Meier may be used to adjust the mean and SD for datasets with single or multiple censoring points (RL). The Kaplan-Meier adjusted mean and SD were calculated using ProUCL 5.1.
2. For datasets that do not include non-detect values, no adjustment to the mean and standard deviation are required prior to calculating the prediction limit.

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix III Parameters

Prediction Limit Calculation

Prediction Limit = x + st[1+(1/n)]^*½

Confidence Level = 95%

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	ND Treatment	Mean [x]	Standard Deviation [s]	Number of Samples	T Value [t]	Prediction Limit Limit	
AP-4	pH (field)	units	6.81	7.07	7.63	7.09	7.04	7.23	7.04	7.1	No Adjustment	7.1986667	0.20	15	2.145	6.7642	7.6332
AP-5	pH (field)	units	7.33	7.19		7.29	7.23	7.46	7.15	7.32							
AP-4	Total Dissolved Solids	mg/l	490	560	448	574	460	578	548	316	No Adjustment	444	85.19	16	1.753	597.9426139	
AP-5	Total Dissolved Solids	mg/l	414	404	316	404	370	410	428	384							
Well	**Parameter**	**Units**	**5/28/15**	**8/20/15**	**11/13/15**	**2/26/16**	**5/13/16**	**8/4/16**	**11/18/16**	**2/16/17**	**ND Treatment**	**Mean**	**Standard Deviation**	**Number of Samples**	**T Value**	**Prediction Limit Limit**	
AP-4	Calcium, total	mg/l	121	117	125	125	118	118	117	136	No Adjustment	124.1	29.07	16	1.753	176.6255938	
AP-5	Calcium, total	mg/l	103	92.2	124	98.1	77.3	158	201	155							

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix IV Parameters

Well	Parameter	Units	2/22/2012	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	Distribution[1]	Proposed Background Value
AP-4	Antimony, total	mg/l	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006	0.0152	< 0.006	< 0.006	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.016
AP-5	Antimony, total	mg/l	< 0.006	< 0.006	0.0063	< 0.0096	< 0.006	0.016	< 0.006	< 0.006		
AP-4	Arsenic, total	mg/l	< 0.05	< 0.05	0.0294	0.00608	< 0.05	0.025	0.0193	< 0.05	Normal - Calculate Interwell Prediction Limit	0.0724
AP-5	Arsenic, total	mg/l	< 0.05	0.076	0.102	0.0243	< 0.05	0.0094	< 0.015	< 0.05		
AP-4	Barium, total	mg/l	< 2	< 2	0.366	< 2	< 2	0.37	0.385	< 2	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	5.24
AP-5	Barium, total	mg/l	5.24	< 2	2.76	< 3.2	< 2	0.13	0.228	< 2		
AP-4	Beryllium, total	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.0164
AP-5	Beryllium, total	mg/l	0.0142	0.0128	0.0092	0.0164	< 0.004	< 0.004	< 0.004	< 0.004		
AP-4	Cadmium, total	mg/l	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.0025	< 0.005	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.0128
AP-5	Cadmium, total	mg/l	0.00776	0.0128	0.00575	< 0.008	< 0.005	< 0.005	< 0.0025	< 0.005		
AP-4	Chromium, total	mg/l	< 0.1	< 0.1	< 0.0175	< 0.1	< 0.1	0.0039	< 0.01	< 0.1	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.811
AP-5	Chromium, total	mg/l	0.811	0.328	0.449	0.42	< 0.1	0.016	0.0431	0.113		
AP-4	Cobalt, total	mg/l	< 1	< 1	< 0.0175	< 1	< 1	< 1	< 0.015	< 1	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.297
AP-5	Cobalt, total	mg/l	< 1	< 1	0.297	< 1.6	< 1	0.0086	0.0223	< 1		
AP-4	Lead, total	mg/l	< 0.0075	< 0.0075	< 0.005	< 0.0075	< 0.0075	0.0036	< 0.005	< 0.0075	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.638
AP-5	Lead, total	mg/l	0.638	0.236	0.312	0.277	0.0244	0.0104	0.0312	0.638		
AP-4	Mercury, total	mg/l	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.0008
AP-5	Mercury, total	mg/l	0.0008	< 0.0005	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005		
AP-4	Selenium, total	mg/l	< 0.05	< 0.05	0.00497	< 0.05	< 0.05	0.0079	< 0.0025	< 0.05	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.0079
AP-5	Selenium, total	mg/l	< 0.05	< 0.05	0.00585	< 0.08	< 0.05	0.0046	0.00523	< 0.05		
AP-4	Thallium, total	mg/l	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	0.00556
AP-5	Thallium, total	mg/l	0.00556	0.00258	0.00302	< 0.0032	< 0.002	< 0.002	< 0.002	< 0.002		

Well	Parameter	Units	5/28/2015	8/20/15	11/13/15	2/26/16	5/13/16	8/4/16	11/18/16	2/16/17	Distribution[1]	Proposed Background Value
AP-4	Lithium	mg/l	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	100% ND - Propose PQL as Prediction Limit	0.05
AP-5	Lithium	mg/l	< 0.05	< 0.05	< 0.25	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05		
AP-4	Molybdenum	mg/l	< 0.025	< 0.025	< 0.05	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	100% ND - Propose PQL as Prediction Limit	0.025
AP-5	Molybdenum	mg/l	< 0.025	< 0.025	< 0.05	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025		

Well	Parameter	Units	8/23/2012	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	2/26/14	5/20/14	Distribution[1]	Proposed Background Value
AP-4	Radium-226	pCi/l	< 0.97	0.41	< 0.57	0.84	< 0.57	0.46	0.91	1.2	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	7.1
AP-5	Radium-226	pCi/l	7.1	< 0.74	1.6	1.1	1	1.8	< -0.04	-0.03		
AP-4	Radium-228	pCi/l	< 0.71	2.3	< 0.83	0.69	< 1.4	< 0.52	0.56	0.53	Not Normal - Propose Highest Detected Concentration as Prediction Limit/Background	5.1
AP-5	Radium-228	pCi/l	5.1	< 1.28	1.6	< 0.68	0.81	1.7	< 1.8	0.95		

Notes:

1. Shapiro-Wilk method utilized to determine if the data set follows a normal distribution. ProUCL 5.1 was used for the calculations. ProUCL 5.1 outputs are provided.

2. In accordance with Section 18.3 of the March 2009 Unified Guidance (Statistical Analysis of Groundwater at RCRA Facilities), the maximum detected concentration is utilized as the interwell prediction limit and proposed background when the dataset does not follow a normal distribution.

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix IV Parameters

Outlier Analysis

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	Number of Samples	Mean	Standard Deviation	Critical Values
AP-4	Arsenic, total	mg/l	< 0.05	< 0.05	0.0294	0.00608	< 0.05	0.025	0.0193	< 0.05	16	0.04103	0.025229	2.747
AP-5	Arsenic, total	mg/l	< 0.05	0.076	0.102	0.0243	< 0.05	0.0094	< 0.015	< 0.05				

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13
AP-4	Arsenic, total	mg/l	0.355548	0.355548	-0.46098	-1.38533	0.355548	-0.63539	-0.86132	0.355548
AP-5	Arsenic, total	mg/l	0.355548	1.386121	2.416694	-0.66313	0.355548	-1.25373	-1.03176	0.355548

Notes:

1. Outlier method presented above outlined is in ASTM paper E178-75 (Grubb's Test).
2. Outliers were also evaluated utilizing Dixon's Test in ProUCL 5.1 at 1% Significance. ProUCL 5.1 output are provided.
3. Outliers that were identified by both methods are noted with a shaded value.

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix IV Parameters

Non-Detect Percentage Analysis

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	Number of Samples	Number of ND's	% ND	ND Treatment
AP-4	Arsenic, total	mg/l	< 0.05	< 0.05	0.0294	0.00608	< 0.05	0.025	0.0193	< 0.05	16	8	50%	Kaplan-Meier
AP-5	Arsenic, total	mg/l	< 0.05	0.076	0.102	0.0243	< 0.05	0.0094	< 0.015	< 0.05				

Notes:

1. For datasets with a fraction of non-detect values from 25% to 50%, adjustments to the mean and standard deviation (SD) are required.
2. For datasets with a single censoring point (RL), Cohen's Ajustment may be used to adjust the mean and SD or a substitution of 1/2 the RL may be used for small datasets (<5) in accordance with Section 15.2 of the March 2009 Unified Guidance (Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities).
3. Kaplan-Meier may be used to adjust the mean and SD for datasets with single or multiple censoring points (RL). The Kaplan-Meier adjusted mean and SD were calculated using ProUCL 5.1.
2. For datasets that do not include non-detect values, no adjustment to the mean and standard deviation are required prior to calculating the prediction limit.

City Water, Light and Power

Power Plant Ash Impoundment

Background Calculations - Interwell Prediction Limits

40 CFR 257 Appendix IV Parameters

Prediction Limit Calculation

Prediction Limit = x + st[1+(1/n)]^*½

Confidence Level = 95%

Well	Parameter	Units	2/22/12	4/25/12	8/23/12	11/28/12	2/21/13	5/22/13	8/28/13	11/20/13	ND Treatment	Mean [x]	Standard Deviation [s]	Number of Samples	T Value [t]	Prediction Limit Limit
AP-4	Arsenic, total	mg/l	< 0.05	< 0.05	0.0294	0.00608	< 0.05	0.025	0.0193	< 0.05	No Adjustment	0.0263	0.0255	16	1.753	0.072377252
AP-5	Arsenic, total	mg/l	< 0.05	0.076	0.102	0.0243	< 0.05	0.0094	< 0.015	< 0.05						

Note:

1. Multiple censoring points (RL's) were observed. Therefore, Kaplan-Meier was utilized to adjust the mean and SD.

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/25/2017 3:46:43 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Arsenic

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	8	8	50.00%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	8	0.015	0.05	0.0456	0.05	0.0124
Statistics (Non-Detects Only)	8	0.00608	0.102	0.0364	0.0247	0.0341
Statistics (All: NDs treated as DL value)	16	0.00608	0.102	0.041	0.05	0.0252
Statistics (All: NDs treated as DL/2 value)	16	0.00608	0.102	0.0296	0.025	0.0247
Statistics (Normal ROS Imputed Data)	16	-0.0127	0.102	0.0268	0.0227	0.0292
Statistics (Gamma ROS Imputed Data)	16	0.00608	0.102	0.0278	0.021	0.0264
Statistics (Lognormal ROS Imputed Data)	16	0.00559	0.102	0.0266	0.0199	0.0265

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	1.472	1.004	0.0247	-3.689	0.946	-0.256
Statistics (NDs = DL)	2.385	1.98	0.0172	-3.418	0.762	-0.223
Statistics (NDs = DL/2)	2.194	1.824	0.0135	-3.764	0.713	-0.189
Statistics (Gamma ROS Estimates)	1.701	1.424	0.0163	-3.905	0.795	-0.204
Statistics (Lognormal ROS Estimates)	--	--	--	-3.982	0.84	-0.211

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.897	0.945	0.795	0.941

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.805	0.818	Data Not Normal
Shapiro-Wilk (NDs = DL)	0.899	0.887	Data Appear Normal
Shapiro-Wilk (NDs = DL/2)	0.653	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.895	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.332	0.283	Data Not Normal
Lilliefors (NDs = DL)	0.236	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.387	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.209	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/25/2017 4:10:09 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Boron

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	8	8	50.00%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	8	0.625	3.2	1.525	1.5	0.924
Statistics (Non-Detects Only)	8	0.0954	0.787	0.443	0.443	0.328
Statistics (All: NDs treated as DL value)	16	0.0954	3.2	0.984	0.719	0.872
Statistics (All: NDs treated as DL/2 value)	16	0.0954	1.6	0.603	0.583	0.421
Statistics (Normal ROS Imputed Data)	16	0.0954	0.787	0.383	0.37	0.255
Statistics (Gamma ROS Imputed Data)	16	0.0954	0.787	0.367	0.313	0.253
Statistics (Lognormal ROS Imputed Data)	16	0.0954	0.787	0.343	0.254	0.26

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	1.601	1.084	0.276	-1.159	0.953	-0.823
Statistics (NDs = DL)	1.286	1.087	0.765	-0.453	1.068	-2.358
Statistics (NDs = DL/2)	1.856	1.55	0.325	-0.8	0.865	-1.081
Statistics (Gamma ROS Estimates)	2.291	1.903	0.16	-1.237	0.718	-0.58
Statistics (Lognormal ROS Estimates)	--	--	--	-1.332	0.742	-0.557

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.898	0.911	0.96	0.943

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.771	0.818	Data Not Normal
Shapiro-Wilk (NDs = DL)	0.831	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.919	0.887	Data Appear Normal
Shapiro-Wilk (Normal ROS Estimates)	0.867	0.887	Data Not Normal
Lilliefors (Detects Only)	0.251	0.283	Data Appear Normal
Lilliefors (NDs = DL)	0.277	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.168	0.213	Data Appear Normal
Lilliefors (Normal ROS Estimates)	0.198	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/25/2017 3:58:26 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Barium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	7	9	56.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	9	2	3.2	2.133	2	0.4
Statistics (Non-Detects Only)	7	0.13	5.24	1.354	0.37	1.946
Statistics (All: NDs treated as DL value)	16	0.13	5.24	1.792	2	1.327
Statistics (All: NDs treated as DL/2 value)	16	0.13	5.24	1.192	1	1.248
Statistics (Normal ROS Imputed Data)	16	-1.289	5.24	0.89	0.378	1.513
Statistics (Gamma ROS Imputed Data)	16	0.01	5.24	0.837	0.344	1.375
Statistics (Lognormal ROS Imputed Data)	16	0.0763	5.24	0.818	0.368	1.342

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	0.712	0.502	1.901	-0.543	1.352	-2.49
Statistics (NDs = DL)	1.387	1.169	1.292	0.182	1.086	5.978
Statistics (NDs = DL/2)	1.445	1.216	0.825	-0.208	0.915	-4.395
Statistics (Gamma ROS Estimates)	0.516	0.461	1.621	-1.402	1.901	-1.356
Statistics (Lognormal ROS Estimates)	--	--	--	-0.9	1.09	-1.212

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.825	0.912	0.8	0.913

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.688	0.803	Data Not Normal
Shapiro-Wilk (NDs = DL)	0.842	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.664	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.855	0.887	Data Not Normal
Lilliefors (Detects Only)	0.405	0.304	Data Not Normal
Lilliefors (NDs = DL)	0.25	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.374	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.218	0.213	Data Not Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/25/2017 4:03:44 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Beryllium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	4	12	75.00%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	12	0.004	0.004	0.004	0.004	9.059E-19
Statistics (Non-Detects Only)	4	0.0092	0.0164	0.0132	0.0135	0.00302
Statistics (All: NDs treated as DL value)	16	0.004	0.0164	0.00629	0.004	0.00431
Statistics (All: NDs treated as DL/2 value)	16	0.002	0.0164	0.00479	0.002	0.00517
Statistics (Normal ROS Imputed Data)	16	-0.01	0.0164	0.0032	0.00292	0.00761
Statistics (Gamma ROS Imputed Data)	16	0.0092	0.0164	0.0108	0.01	0.00195
Statistics (Lognormal ROS Imputed Data)	16	0.00207	0.0164	0.00694	0.00575	0.00426

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	23.28	5.987	5.6479E-4	-4.353	0.246	-0.0564
Statistics (NDs = DL)	3.279	2.706	0.00192	-5.229	0.534	-0.102
Statistics (NDs = DL/2)	1.37	1.155	0.00349	-5.749	0.84	-0.146
Statistics (Gamma ROS Estimates)	39.38	32.04	2.7394E-4	-4.542	0.157	-0.0347
Statistics (Lognormal ROS Estimates)	--	--	--	-5.138	0.601	-0.117

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.987	0.77	0.772	0.997

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.981	0.748	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.593	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.593	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.984	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.204	0.375	Data Appear Normal
Lilliefors (NDs = DL)	0.452	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.455	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.084	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 5:05:12 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Calcium

Raw Statistics

Number of Valid Observations	16
Number of Distinct Observations	13
Minimum	77.3
Maximum	201
Mean of Raw Data	124.1
Standard Deviation of Raw Data	29.07
Khat	20.96
Theta hat	5.92
Kstar	17.08
Theta star	7.268
Mean of Log Transformed Data	4.797
Standard Deviation of Log Transformed Data	0.224

Normal GOF Test Results

Correlation Coefficient R	0.944
Shapiro Wilk Test Statistic	0.909
Shapiro Wilk Critical (0.05) Value	0.887
Approximate Shapiro Wilk P Value	0.0906
Lilliefors Test Statistic	0.238
Lilliefors Critical (0.05) Value	0.213

Data appear Approximate Normal at (0.05) Significance Level

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 9:51:59 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Cadmium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	3	13	81.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	13	0.0025	0.008	0.00485	0.005	0.00133
Statistics (Non-Detects Only)	3	0.00575	0.0128	0.00877	0.00776	0.00363
Statistics (All: NDs treated as DL value)	16	0.0025	0.0128	0.00558	0.005	0.00238
Statistics (All: NDs treated as DL/2 value)	16	0.00125	0.0128	0.00361	0.0025	0.00294
Statistics (Normal ROS Imputed Data)	16	-0.015	0.0128	-0.00253	-0.00298	0.00727
Statistics (Gamma ROS Imputed Data)	16	0.00575	0.0128	0.00977	0.01	0.00142
Statistics (Lognormal ROS Imputed Data)	16	6.0454E-4	0.0128	0.00329	0.00227	0.00316

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (NDs = DL)	7.069	5.785	7.8965E-4	-5.261	0.388	-0.0737
Statistics (NDs = DL/2)	2.647	2.192	0.00136	-5.824	0.599	-0.103
Statistics (Gamma ROS Estimates)	42.99	34.97	2.2724E-4	-4.64	0.166	-0.0357
Statistics (Lognormal ROS Estimates)	--	--	--	-6.04	0.803	-0.133

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.971	0.835	0.784	0.992

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.942	0.767	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.726	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.636	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.984	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.276	0.425	Data Appear Normal
Lilliefors (NDs = DL)	0.346	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.397	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.103	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 1:58:45 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Chloride

Raw Statistics

Number of Valid Observations	16
Number of Distinct Observations	15
Minimum	1.95
Maximum	24.2
Mean of Raw Data	8.356
Standard Deviation of Raw Data	5.632
Khat	2.299
Theta hat	3.635
Kstar	1.91
Theta star	4.376
Mean of Log Transformed Data	1.89
Standard Deviation of Log Transformed Data	0.745

Normal GOF Test Results

Correlation Coefficient R	0.896
Shapiro Wilk Test Statistic	0.815
Shapiro Wilk Critical (0.05) Value	0.887
Approximate Shapiro Wilk P Value	0.00346
Lilliefors Test Statistic	0.257
Lilliefors Critical (0.05) Value	0.213

Data not Normal at (0.05) Significance Level

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 2:30:51 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Cobalt

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	3	13	81.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	13	0.015	1.6	0.895	1	0.423
Statistics (Non-Detects Only)	3	0.0086	0.297	0.109	0.0223	0.163
Statistics (All: NDs treated as DL value)	16	0.0086	1.6	0.748	1	0.497
Statistics (All: NDs treated as DL/2 value)	16	0.0075	0.8	0.384	0.5	0.241
Statistics (Normal ROS Imputed Data)	16	-0.146	0.297	0.0515	0.0278	0.118
Statistics (Gamma ROS Imputed Data)	16	0.0086	0.323	0.0699	0.0104	0.106
Statistics (Lognormal ROS Imputed Data)	16	0.00135	0.297	0.0524	0.0159	0.0874

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (NDs = DL)	0.744	0.646	1.005	-1.097	1.889	-1.722
Statistics (NDs = DL/2)	0.839	0.723	0.458	-1.66	1.746	-1.052
Statistics (Gamma ROS Estimates)	0.636	0.558	0.11	-3.625	1.353	-0.373
Statistics (Lognormal ROS Estimates)	--	--	--	-4.015	1.498	-0.373

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.886	0.868	0.867	0.98

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.786	0.767	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.75	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.751	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.961	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.37	0.425	Data Appear Normal
Lilliefors (NDs = DL)	0.382	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.373	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.136	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 2:15:26 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Chromium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	8	8	50.00%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	8	0.01	0.1	0.0784	0.1	0.04
Statistics (Non-Detects Only)	8	0.0039	0.811	0.273	0.221	0.283
Statistics (All: NDs treated as DL value)	16	0.0039	0.811	0.176	0.1	0.22
Statistics (All: NDs treated as DL/2 value)	16	0.0039	0.811	0.156	0.05	0.229
Statistics (Normal ROS Imputed Data)	16	-0.299	0.811	0.103	0.0296	0.281
Statistics (Gamma ROS Imputed Data)	16	0.0039	0.811	0.147	0.0202	0.234
Statistics (Lognormal ROS Imputed Data)	16	0.00144	0.811	0.144	0.0212	0.236

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	0.643	0.485	0.425	-2.25	1.878	-0.835
Statistics (NDs = DL)	0.757	0.656	0.232	-2.529	1.466	-0.58
Statistics (NDs = DL/2)	0.606	0.534	0.258	-2.876	1.576	-0.548
Statistics (Gamma ROS Estimates)	0.483	0.434	0.304	-3.239	1.723	-0.532
Statistics (Lognormal ROS Estimates)	--	--	--	-3.525	1.996	-0.566

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.942	0.845	0.817	0.957

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.88	0.818	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.725	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.677	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.924	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.214	0.283	Data Appear Normal
Lilliefors (NDs = DL)	0.362	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.366	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.174	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 2:43:21 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Fluoride

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	3	13	81.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	13	0.5	0.5	0.5	0.5	0
Statistics (Non-Detects Only)	3	0.2	0.62	0.417	0.43	0.21
Statistics (All: NDs treated as DL value)	16	0.2	0.62	0.484	0.5	0.0838
Statistics (All: NDs treated as DL/2 value)	16	0.2	0.62	0.281	0.25	0.102
Statistics (Normal ROS Imputed Data)	16	0.0634	0.62	0.323	0.321	0.15
Statistics (Gamma ROS Imputed Data)	16	0.155	0.62	0.33	0.314	0.126
Statistics (Lognormal ROS Imputed Data)	16	0.149	0.62	0.317	0.293	0.128

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (NDs = DL)	23.42	19.07	0.0207	-0.746	0.24	-0.321
Statistics (NDs = DL/2)	12.34	10.07	0.0228	-1.31	0.268	-0.204
Statistics (Gamma ROS Estimates)	7.453	6.097	0.0443	-1.177	0.385	-0.327
Statistics (Lognormal ROS Estimates)	--	--	--	-1.222	0.397	-0.325

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.998	0.692	0.665	0.997

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.997	0.767	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.526	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.472	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.991	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.192	0.425	Data Appear Normal
Lilliefors (NDs = DL)	0.449	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.495	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.0794	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 2:58:10 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Mercury

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	2	14	87.50%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	14	5.0000E-4	5.0000E-4	5.0000E-4	5.0000E-4	2.250E-19
Statistics (Non-Detects Only)	2	7.0000E-4	8.0000E-4	7.5000E-4	7.5000E-4	7.0711E-5
Statistics (All: NDs treated as DL value)	16	5.0000E-4	8.0000E-4	5.3125E-4	5.0000E-4	8.7321E-5
Statistics (All: NDs treated as DL/2 value)	16	2.5000E-4	8.0000E-4	3.1250E-4	2.5000E-4	1.7176E-4
Statistics (Normal ROS Imputed Data)	16	-1.466E-4	8.0000E-4	3.0705E-4	3.0035E-4	2.6145E-4
Statistics (Gamma ROS Imputed Data)	16	N/A	N/A	N/A	N/A	N/A
Statistics (Lognormal ROS Imputed Data)	16	2.2601E-4	8.0000E-4	4.3882E-4	4.1068E-4	1.5791E-4

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (NDs = DL)	49.09	39.93	1.0822E-5	-7.55	0.14	-0.0185
Statistics (NDs = DL/2)	5.969	4.892	5.2352E-5	-8.157	0.375	-0.046
Statistics (Gamma ROS Estimates)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (Lognormal ROS Estimates)	--	--	--	-7.789	0.349	-0.0448

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	1	0.628	0.628	0.998

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (NDs = DL)	0.414	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.41	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.992	0.887	Data Appear Normal
Lilliefors (Detects Only)	N/A	N/A	
Lilliefors (NDs = DL)	0.515	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.517	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.0586	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 5:07:40 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Lithium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	0	16	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Lithium was not processed!

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 5:08:42 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Molybdenum

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	0	16	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!

Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Molybdenum was not processed!

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 2:53:27 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Lead

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	9	7	43.75%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	7	0.005	0.0075	0.00679	0.0075	0.00122
Statistics (Non-Detects Only)	9	0.0036	0.638	0.241	0.236	0.255
Statistics (All: NDs treated as DL value)	16	0.0036	0.638	0.139	0.00895	0.222
Statistics (All: NDs treated as DL/2 value)	16	0.0025	0.638	0.137	0.00708	0.223
Statistics (Normal ROS Imputed Data)	16	-0.428	0.638	0.0464	0.007	0.307
Statistics (Gamma ROS Imputed Data)	16	0.0036	0.638	0.14	0.0102	0.221
Statistics (Lognormal ROS Imputed Data)	16	4.0641E-4	0.638	0.137	0.0101	0.223

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	0.595	0.47	0.406	-2.463	1.911	-0.776
Statistics (NDs = DL)	0.41	0.374	0.338	-3.577	1.915	-0.535
Statistics (NDs = DL/2)	0.354	0.33	0.387	-3.88	2.172	-0.56
Statistics (Gamma ROS Estimates)	0.45	0.407	0.311	-3.4	1.776	-0.522
Statistics (Lognormal ROS Estimates)	--	--	--	-4.02	2.4	-0.597

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.923	0.812	0.813	0.969

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.827	0.829	Data Not Normal
Shapiro-Wilk (NDs = DL)	0.654	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.656	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.934	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.239	0.274	Data Appear Normal
Lilliefors (NDs = DL)	0.373	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.37	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.207	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.110/3/2017 9:00:31 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

pH

Raw Statistics

Number of Valid Observations	15
Number of Distinct Observations	13
Minimum	6.81
Maximum	7.63
Mean of Raw Data	7.199
Standard Deviation of Raw Data	0.196
Khat	1450
Theta hat	0.00497
Kstar	1160
Theta star	0.00621
Mean of Log Transformed Data	1.974
Standard Deviation of Log Transformed Data	0.0272

Normal GOF Test Results

Correlation Coefficient R	0.977
Shapiro Wilk Test Statistic	0.969
Shapiro Wilk Critical (0.05) Value	0.881
Approximate Shapiro Wilk P Value	0.725
Lilliefors Test Statistic	0.143
Lilliefors Critical (0.05) Value	0.22

Data appear Normal at (0.05) Significance Level

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/28/2017 11:48:02 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Ra226

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	11	5	31.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	5	-0.04	0.97	0.562	0.57	0.374
Statistics (Non-Detects Only)	11	-0.03	7.1	1.49	1	1.933
Statistics (All: NDs treated as DL value)	16	-0.04	7.1	1.2	0.875	1.651
Statistics (All: NDs treated as DL/2 value)	16	N/A	N/A	N/A	N/A	N/A
Statistics (Normal ROS Imputed Data)	16	-2.249	7.1	0.749	0.65	1.995

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.76	0.728	0.733	0.869

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.611	0.85	Data Not Normal
Shapiro-Wilk (NDs = DL)	0.561	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.567	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.789	0.887	Data Not Normal
Lilliefors (Detects Only)	0.345	0.251	Data Not Normal
Lilliefors (NDs = DL)	0.313	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.292	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.237	0.213	Data Not Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/28/2017 11:49:12 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Ra228

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	9	7	43.75%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	7	0.52	1.8	1.027	0.83	0.466
Statistics (Non-Detects Only)	9	0.53	5.1	1.582	0.95	1.451
Statistics (All: NDs treated as DL value)	16	0.52	5.1	1.339	0.89	1.136
Statistics (All: NDs treated as DL/2 value)	16	0.26	5.1	1.115	0.695	1.202
Statistics (Normal ROS Imputed Data)	16	-1.431	5.1	0.846	0.553	1.428
Statistics (Gamma ROS Imputed Data)	16	0.01	5.1	0.963	0.545	1.289
Statistics (Lognormal ROS Imputed Data)	16	0.202	5.1	1.095	0.604	1.207

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	1.94	1.367	0.816	0.179	0.749	4.172
Statistics (NDs = DL)	2.452	2.034	0.546	0.0746	0.628	8.42
Statistics (NDs = DL/2)	1.63	1.366	0.684	-0.229	0.78	-3.411
Statistics (Gamma ROS Estimates)	0.608	0.536	1.583	-1.052	1.865	-1.773
Statistics (Lognormal ROS Estimates)	--	--	--	-0.255	0.787	-3.079

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.851	0.814	0.795	0.904

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.739	0.829	Data Not Normal
Shapiro-Wilk (NDs = DL)	0.683	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.655	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.846	0.887	Data Not Normal
Lilliefors (Detects Only)	0.245	0.274	Data Appear Normal
Lilliefors (NDs = DL)	0.235	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.304	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.221	0.213	Data Not Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/25/2017 3:43:44 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Antimony

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	3	13	81.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	13	0.006	0.0096	0.00628	0.006	9.9846E-4
Statistics (Non-Detects Only)	3	0.0063	0.016	0.0125	0.0152	0.00538
Statistics (All: NDs treated as DL value)	16	0.006	0.016	0.00744	0.006	0.00331
Statistics (All: NDs treated as DL/2 value)	16	0.003	0.016	0.00489	0.003	0.00428
Statistics (Normal ROS Imputed Data)	16	-0.0265	0.016	-0.00565	-0.00701	0.0121
Statistics (Gamma ROS Imputed Data)	16	0.0063	0.016	0.0105	0.01	0.00221
Statistics (Lognormal ROS Imputed Data)	16	2.7001E-4	0.016	0.00379	0.00177	0.00489

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (NDs = DL)	8.001	6.542	9.3037E-4	-4.964	0.335	-0.0674
Statistics (NDs = DL/2)	2.563	2.124	0.00191	-5.527	0.574	-0.104
Statistics (Gamma ROS Estimates)	26.29	21.4	3.9826E-4	-4.579	0.2	-0.0436
Statistics (Lognormal ROS Estimates)	--	--	--	-6.209	1.159	-0.187

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.901	0.7	0.704	0.992

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.811	0.767	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.498	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.504	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.978	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.359	0.425	Data Appear Normal
Lilliefors (NDs = DL)	0.448	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.421	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.0832	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 3:03:58 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Selenium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	5	11	68.75%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	11	0.0025	0.08	0.0484	0.05	0.0177
Statistics (Non-Detects Only)	5	0.0046	0.0079	0.00571	0.00523	0.00131
Statistics (All: NDs treated as DL value)	16	0.0025	0.08	0.0351	0.05	0.025
Statistics (All: NDs treated as DL/2 value)	16	0.00125	0.04	0.0184	0.025	0.0114
Statistics (Normal ROS Imputed Data)	16	0.00251	0.0079	0.00521	0.00522	0.00155
Statistics (Gamma ROS Imputed Data)	16	0.0046	0.01	0.00866	0.01	0.00216
Statistics (Lognormal ROS Imputed Data)	16	0.0033	0.0079	0.00532	0.00517	0.00136

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	26.79	10.85	2.1315E-4	-5.184	0.211	-0.0407
Statistics (NDs = DL)	1.165	0.988	0.0301	-3.838	1.211	-0.315
Statistics (NDs = DL/2)	1.71	1.431	0.0108	-4.314	0.976	-0.226
Statistics (Gamma ROS Estimates)	13.66	11.14	6.3377E-4	-4.786	0.298	-0.0622
Statistics (Lognormal ROS Estimates)	--	--	--	-5.268	0.255	-0.0485

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.916	0.878	0.896	0.987

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.848	0.762	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.764	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.801	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.967	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.257	0.343	Data Appear Normal
Lilliefors (NDs = DL)	0.35	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.342	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.119	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 4:56:42 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Sulfate

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	9	7	43.75%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	7	5	5	5	5	0
Statistics (Non-Detects Only)	9	0.3	84.5	61.38	66.8	26.96
Statistics (All: NDs treated as DL value)	16	0.3	84.5	36.71	24.25	34.96
Statistics (All: NDs treated as DL/2 value)	16	0.3	84.5	35.62	23	36.02
Statistics (Normal ROS Imputed Data)	16	-20.67	84.5	38.83	38	35
Statistics (Gamma ROS Imputed Data)	16	0.3	84.5	46.67	39.94	26.42
Statistics (Lognormal ROS Imputed Data)	16	0.3	84.5	35.84	25.4	35.84

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	1.122	0.822	54.73	3.609	1.819	0.504
Statistics (NDs = DL)	0.696	0.607	52.74	2.734	1.677	0.613
Statistics (NDs = DL/2)	0.548	0.487	64.95	2.431	1.915	0.788
Statistics (Gamma ROS Estimates)	1.506	1.265	31	3.476	1.344	0.387
Statistics (Lognormal ROS Estimates)	--	--	--	2.343	2.098	0.896

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.907	0.901	0.895	0.977

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.83	0.829	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.785	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.773	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.935	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.196	0.274	Data Appear Normal
Lilliefors (NDs = DL)	0.318	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.321	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.119	0.213	Data Appear Normal

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 5:02:40 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

TDS

Raw Statistics

Number of Valid Observations	16
Number of Distinct Observations	14
Minimum	316
Maximum	578
Mean of Raw Data	444
Standard Deviation of Raw Data	85.19
Khat	29.07
Theta hat	15.27
Kstar	23.66
Theta star	18.76
Mean of Log Transformed Data	6.079
Standard Deviation of Log Transformed Data	0.193

Normal GOF Test Results

Correlation Coefficient R	0.971
Shapiro Wilk Test Statistic	0.927
Shapiro Wilk Critical (0.05) Value	0.887
Approximate Shapiro Wilk P Value	0.271
Lilliefors Test Statistic	0.139
Lilliefors Critical (0.05) Value	0.213

Data appear Normal at (0.05) Significance Level

Goodness-of-Fit Test Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.19/26/2017 4:59:14 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95

Thallium

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	16	0	16	3	13	81.25%

	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	13	0.002	0.0032	0.00209	0.002	3.3282E-4
Statistics (Non-Detects Only)	3	0.00258	0.00556	0.00372	0.00302	0.00161
Statistics (All: NDs treated as DL value)	16	0.002	0.00556	0.0024	0.002	9.2960E-4
Statistics (All: NDs treated as DL/2 value)	16	0.001	0.00556	0.00155	0.001	0.00124
Statistics (Normal ROS Imputed Data)	16	-0.00705	0.00556	-0.00129	-0.00153	0.00333
Statistics (Gamma ROS Imputed Data)	16	0.00258	0.01	0.00882	0.01	0.0026
Statistics (Lognormal ROS Imputed Data)	16	2.2972E-4	0.00556	0.00139	9.2841E-4	0.00136

	K hat	K Star	Theta hat	Log Mean	Log Stdv	Log CV
Statistics (Non-Detects Only)	N/A	N/A	N/A	N/A	N/A	N/A
Statistics (NDs = DL)	10.96	8.944	2.1882E-4	-6.08	0.284	-0.0467
Statistics (NDs = DL/2)	3.068	2.535	5.0437E-4	-6.643	0.527	-0.0793
Statistics (Gamma ROS Estimates)	7.213	5.902	0.00122	-4.801	0.447	-0.0931
Statistics (Lognormal ROS Estimates)	--	--	--	-6.92	0.842	-0.122

Normal GOF Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.926	0.696	0.714	0.995

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Shapiro-Wilk (Detects Only)	0.858	0.767	Data Appear Normal
Shapiro-Wilk (NDs = DL)	0.507	0.887	Data Not Normal
Shapiro-Wilk (NDs = DL/2)	0.529	0.887	Data Not Normal
Shapiro-Wilk (Normal ROS Estimates)	0.991	0.887	Data Appear Normal
Lilliefors (Detects Only)	0.335	0.425	Data Appear Normal
Lilliefors (NDs = DL)	0.416	0.213	Data Not Normal
Lilliefors (NDs = DL/2)	0.421	0.213	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.0776	0.213	Data Appear Normal

Outlier Tests for Selected Variables excluding nondetects

User Selected Options

Date/Time of Computation ProUCL 5.19/27/2017 3:54:50 PM

From File WorkSheet.xls

Full Precision OFF

Dixon's Outlier Test for Arsenic

Total N = 16

Number NDs = 8

Number Detects = 8

10% critical value: 0.479

5% critical value: 0.554

1% critical value: 0.683

Note: NDs excluded from Outlier Test

1. Data Value 0.102 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.281

For 10% significance level, 0.102 is not an outlier.

For 5% significance level, 0.102 is not an outlier.

For 1% significance level, 0.102 is not an outlier.

2. Data Value 0.00608 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.047

For 10% significance level, 0.00608 is not an outlier.

For 5% significance level, 0.00608 is not an outlier.

For 1% significance level, 0.00608 is not an outlier.

Outlier Tests for Selected Variables excluding nondetects

User Selected Options

Date/Time of Computation ProUCL 5.19/28/2017 11:52:22 AM

From File WorkSheet.xls

Full Precision OFF

Dixon's Outlier Test for Calcium

Total N = 16

Number NDs = 0

Number Detects = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

Note: NDs excluded from Outlier Test

1. Data Value 201 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.447

For 10% significance level, 201 is not an outlier.

For 5% significance level, 201 is not an outlier.

For 1% significance level, 201 is not an outlier.

2. Data Value 77.3 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.268

For 10% significance level, 77.3 is not an outlier.

For 5% significance level, 77.3 is not an outlier.

For 1% significance level, 77.3 is not an outlier.

Outlier Tests for Selected Variables excluding nondetects

User Selected Options

Date/Time of Computation ProUCL 5.19/27/2017 3:39:01 PM

From File WorkSheet.xls

Full Precision OFF

Dixon's Outlier Test for pH

Total N = 15

Number NDs = 0

Number Detects = 15

10% critical value: 0.472

5% critical value: 0.525

1% critical value: 0.616

Note: NDs excluded from Outlier Test

1. Data Value 7.63 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.508

For 10% significance level, 7.63 is an outlier.

For 5% significance level, 7.63 is not an outlier.

For 1% significance level, 7.63 is not an outlier.

2. Data Value 6.81 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.442

For 10% significance level, 6.81 is not an outlier.

For 5% significance level, 6.81 is not an outlier.

For 1% significance level, 6.81 is not an outlier.

Outlier Tests for Selected Variables excluding nondetects

User Selected Options

Date/Time of Computation ProUCL 5.19/27/2017 3:36:41 PM

From File WorkSheet.xls

Full Precision OFF

Dixon's Outlier Test for TDS

Total N = 16

Number NDs = 0

Number Detects = 16

10% critical value: 0.454

5% critical value: 0.507

1% critical value: 0.595

Note: NDs excluded from Outlier Test

1. Data Value 578 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.087

For 10% significance level, 578 is not an outlier.

For 5% significance level, 578 is not an outlier.

For 1% significance level, 578 is not an outlier.

2. Data Value 316 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.221

For 10% significance level, 316 is not an outlier.

For 5% significance level, 316 is not an outlier.

For 1% significance level, 316 is not an outlier.

Background Statistics for Data Sets with Non-Detects

User Selected Options

Date/Time of Computation	ProUCL 5.110/3/2017 10:23:39 AM
From File	Data Sept28.xls
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Observations	1
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Total Number of Observations	16	Number of Missing Observations	0
Number of Distinct Observations	10		
Number of Detects	8	Number of Non-Detects	8
Number of Distinct Detects	8	Number of Distinct Non-Detects	2
Minimum Detect	0.00608	Minimum Non-Detect	0.015
Maximum Detect	0.102	Maximum Non-Detect	0.05
Variance Detected	0.00116	Percent Non-Detects	50%
Mean Detected	0.0364	SD Detected	0.0341
Mean of Detected Logged Data	-3.689	SD of Detected Logged Data	0.946

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	2.524	d2max (for USL)	2.443

Kaplan Meier (KM) Background Statistics Assuming Normal Distribution

KM Mean	**0.0263**	**KM SD**	**0.0255**
95% UTL95% Coverage	0.0907	95% KM UPL (t)	0.0724
90% KM Percentile (z)	0.059	95% KM Percentile (z)	0.0682
99% KM Percentile (z)	0.0856	95% KM USL	0.0886